Nomination of
FORMER CORRIMAL COKE WORKS
for the award of an
Engineering Heritage Marker

Oblique Aerial photo of Corrimal Coke Works 2018 **Source Illawarra Coke Company**

C1 Coke Ovens Battery, Quench Towers and Stacks, Fine Coal Bins July 2018 *source unknown*

by Douglas Boleyn
Engineering Heritage - Sydney
December 2020

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Appendices

1. Nomination Letter

Learned Body Advisor
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Nominated Item:	**Former Corrimal Coke Works**
Nomination:	**This item is nominated for the recognition under Engineers Australia Engineering Heritage Recognition Program**
Location:	**Lot 1 Railway Street, Corrimal, NSW**
Owner:	**Illawarra Coke Company Pty Ltd** The owner has declined a request for it to agree to the Corrimal Coke Works being recognised under the Engineers Australia's Heritage Recognition Program
Access to Site:	three entrances *off* **Railway Street, Corrimal**
Nominating Body:	**Engineering Heritage Sydney [EHS]**

Frank Johnson

Chair
Engineering Heritage Sydney

Date

2. Introduction

2.1 Background

The Corrimal Coke Works operated for over 100 years (1912 - 2014) and was arguably the longest continuously operating coke-works in Australia [(1)].

Over its life, Corrimal Coke Works supplied premium grade coke for metallurgical processing and founding to Australian and overseas base-metal producers and foundries. It was initially built with a capacity of 55,000 tonnes annually produced by 40 ovens [C1battery] and at its peak, with the later added 10 C1 battery ovens and 32 C2 battery ovens, it had a production capacity of over 100,000 tonnes annually. In its early years most of its production went to local users and in its later years, up to 70% went overseas.[(2)] *[Roughly 80% to metallurgical coke smelters, 10% foundries, < 10% nut and breeze]*

Using Bulli Seam coal mined in the northern Illawarra, the Corrimal Coke Works produced premium hard grade coke for metallurgical processing and foundry operations for use by Australian and overseas producers of base metals - iron, copper, lead, zinc and of precious metals - silver and gold producers.

The coke-works site is a visual reminder of the role metallurgical coke-making played in the coal, smelting, founding and blacksmithing industries; locally, elsewhere and overseas.

The coke-works was a key component in the establishment of Corrimal as a suburb and ensured the economic health of the locality as a continuous employer of local families and is socially significant to the generations who built, operated and maintained the coke-works.

As the oldest continually operated coke works in Australia, the Corrimal Coke Works demonstrates the changes and upgrades that occurred in the industry following the introduction of new technology – automation and improvements to comply with safety and environmental legislation. These works have the potential to yield information pertaining to the development of coke-making in an Australian context.

As industrial sites, coke works are now a rare and endangered physical record of what was once a major component of the industrial past of the Illawarra, NSW and of Australia generally.

Whilst the Corrimal Coke Works is no longer fully intact, it and another in NSW - Coalcliff and one in Queensland – Bowen [if demolition has not been completed], is the only remaining examples of the longitudinal bee-hive ovens remaining in Australia.

It is therefore of a high representative value. These coke ovens, in particular, are important in demonstrating the principal characteristics of a now under-represented industry of local and national heritage significance.

2.2 Category of Award

It is recommended that the former Corrimal Coke Works, be considered for recognition by Engineers Australia for its engineering heritage significance by Engineers Australia learned society Engineering Heritage Australia under its Engineering Heritage Recognition Program.

(1) Comment: It is conceivable that the Corrimal Coke Works which dates from 1912 was, at the time of their closure in 2014, the longest continuously operating coke-works in the world utilizing the original ovens.
The oldest coke works in the US is USS Clairton coke works which has been in operation since 1918 and is still in operation.
The oldest merchant coke works in the UK is Monkton Coke Works which was in operation from 1884 to 2014 but there was a partial break of 3 years when new replacement ovens were built between 1976 and 1979.

The assertion was made by the then Chairman of the Illawarra Coke Company Paul Seshold at the centenary celebrations [Illawarra Mercury March 21 2012]

(2). Initially all the production was for domestic markets and this continued up until the 1960s.
After the closure of the Lead-Zinc smelter at Cockle Creek just south of Newcastle in 2003, most of Corrimal's coke markets went to export.
In recent years, the only customers for metallurgical coke were iron and steel blast furnaces and lead- zinc smelters.

At a later date, the Owners Corporation of the proposed residential development on the site, may be amenable to commemorating the retained infrastructure with a plaque together with an interpretive panel, describing the history of the Works and its heritage significance.

2.3 Interpretation

The Illawarra Coke Company Holding Pty Ltd has not agreed to the site being recognised under Engineering Heritage Australia's recognition program.

As a consequence, it is recommended that the former Corrimal Coke Works should be accorded virtual recognition of this under-represented industry of national significance.

3 Basic Data

Current Name:	*former* Corrimal Coke Works	
Former Names:	Corrimal-Balgownie Coke Works	
Location:	Corrimal, NSW *refer page 12 for a location map*	
Address:	Lot 1 Railway Street, Corrimal NSW	
Local Government Area:	Wollongong City Council	
Owner:	Illawarra Coke Company Holdings Pty Ltd	1996
Previous Owners:	Southern Coal Company owned by G S Yuill	1911 – 1912
	Corrimal-Balgownie Collieries Pty Ltd	
	Corrimal Coal and Coke Company	
	Australian Iron and Steel Ltd	1964
	Bellambi Coal Company	1969
	Australian Coal & Coke Pty. Limited	1980
	Illawarra Coke Company Pty Limited	1984
Current Use:	Proposed residential development site	
Former Use:	Producer of premium grade metallurgical and foundry coke Producer of electricity to its associated mine and to the local municipal council area between 1918 and the mid-1960s for council's and domestic use.[3]	
Designer:	Unknown. It was reported in the press of the day [4] a consulting engineer Mr J Meekan assisted in the design of the ovens	
Builder:	Day-labour and sub-contract.	
Year Started:	Light up	May 1912 [Illawarra Mercury 6 September 1912]
	Official Opening	5 September 1912
Year Closed:	Final oven push	28 March 2014
	Gates shut	3 April 2014

3 Corrimal Coke Works sold its local electricity reticulation network which covered the North Illawarra Council area to Greater Wollongong City Council in 1949 for £30,000 [$60,000]. The Corrimal Coke Works continued to supply power to the network until 1966 when the generators were removed after BHP had bought the Corrimal Colliery.

4 Sydney Morning Herald 6 September 1912 page 7

4. Description, Condition and Modifications

4.1 Physical Description and Operation of Coke Works

A labelled layout of the Corrimal Coke Works is included in 4.4 and photos of the coke-works during its life are in included in Appendix 3. The several production elements of the coke-works are noted in bold.

Corrimal Coke Works was a small complex of operational plant and buildings located in the north-east of the property – refer cover aerial photo, with cleared stockpile areas, dams, access roads and lightly timbered riparian areas.

There are two **batteries C1 and C2.** Its coke ovens are of the non-recovery [where valuable concentrated carbon-based coke oven gases and liquids are not recovered] heat recovery [where the burnt waste gases heat is recovered for use] design.

The following is an overview of the process of making coke – the carbonization of coal, for one battery from the charging of coal to the withdrawing of the coke – a production cycle.
The process at various times in the life of the coke-works is described in greater detail in Appendix 2.
The description below presents the operational sequence at the time of closure of the coke-works.

Washed coal was delivered by truck directly to a hard-standing area and some to the **coal storage shed**]**.** From here the coal was loaded by front-end loader into the coal receival hopper which fed a conveyor that transferred the coal to the **grinding plant** [Cagepactor crusher] where it was crushed and then transferred to storage by conveyor to the **fine coal storage bins.** Recycled waste oil was also added to the coal after crushing to increase the bulk density of the crushed coal charge, this increased the tonnage charged into the oven and improved the resultant coke strength and other coke quality parameters.

The bin for C1 battery was linked to the bin for C2 battery by a cross-over conveyor. [Photo 6]

Originally, the coal arrived from Corrimal Colliery by rail via a siding off the 1889 tramway that had been built to take coal to the government railway. The bottom dump hoppers were shunted up an inclined ramp to a timber gantry [Photo 12] and the coal dumped to under the gantry into 1500 ton railway sleeper walled hopper. From there the coal was taken by a scraper chain conveyor to the coal grinder.,

From beneath **the coal fines bin** an electrically-driven **charge car** [originally referred to as a cannisters] [Photos 9, 10] – which had three built-in hoppers, was filled with sufficient coal to charge one oven. The charge car, powered by an overhead collector system, then ran on rails along the top of the battery, stopped at the selected oven, magnetically removed the three iron lids with on board magnets, and then charged the oven through the three charge holes in its roof and replaced the lids.

A leveller beam with a scraper end operated from the ram car, was used to evenly distribute the coal in the oven.

To avoid air pollution from the emissions of smoke and particulates, the charge car was fitted with a vacuum charging emissions collection system. Having captured emissions from each charge hole, passed through a baghouse where the particulate matter was retained and clarified air discharged

The production cycle time i.e. the time between when the oven was charged until the coke was pushed out, could be two, three, or more days, depending on such variables such as - the product required, the charge and for the oven geometry, height of flue level and charge car ram level. A longer cycle allowed a greater coal charge. The usual practice was half the ovens were pushed Monday and Thursday and the other half on Tuesday and Friday. [Because of EPA restrictions no pushing was carried out on weekends]

The oven retained sufficient heat from its last use to ignite the gas evolved from the coal surface and start the carbonisation process of the coal with the hot wall of the oven. During the coking process, the hot waste gases of combustion were drawn from each oven, via individual connections, into an underground common flue that ran to two stacks - one at each end of the battery, where the hot waste gases were discharged to atmosphere. The draught to each stack, and hence the amount of combustion air aspirated into each oven could be controlled by raising or lowering refractory knife-

blade dampers located at the ends of the flue. Individual control of combustion air to each oven would be controlled by changing the area of the hole in the end door through which the air was ”sucked”.

The coke-making process involves combusting coal to release the volatile organic products contained in the coal and burn them to release heat in a gaseous form. This process in turn converts the coal into a hard, strong carbon matrix, with some mineral matter content, termed “coke”

The main volatile products are complex varieties of carbon compounds, which when heated in air, combust to form carbon dioxide, water vapour and, lots of heat.

The coke ovens utilised the combustion of the waste gas products continuously generated from the heating of the coal to continue coking of the remaining coal until the gases are exhausted and the entire coal charge has been converted to coke. As a result of this combustion, the ovens produce large amounts of waste heat, which other than for the coking process can be used to raise steam for electrical power generation; as was the case for Corrimal Coke Works

Up until 1967, the hot waste gases from **Battery C1** could be diverted from the common flue, into an overground refractory-lined duct that went to the **Power House** to raise steam in boilers to generate electrical power.
Originally, C1 battery had two **100ft high brick stacks**– the southern brick stack discharged waste gases not diverted to the **Power House** and remains on-site. The C1 battery northern brick stack was replaced by a refractory brick-lined **steel stack** in 1960 as part of the expansion of the Power House.

At the conclusion of each oven’s production cycle the hot coke was pushed out of the oven by an electrically operated **ram car** into a waiting **hot-car** [It was originally discharged onto a concrete apron to be quenched by hand- held hoses] that ran on rails to its **quench tower.**
The 19th century ram car had been brought from Unanderra Coke Works.

From the late-1990s new hoods were installed along the battery to capture the fine particulate emissions released from an oven when it was opened for the coke to be discharged into **the hot cars**

When the hot car arrived under its quench tower it was flooded with high volumes of water [which was drawn from on-site ponds which used to fill the quench tower tanks] doused the hot coke to terminate further combustion. The steam generated from quenching went to atmosphere via **stacks.**

There was one quencher and stack for each battery. Both quenchers took their water from a common quench basin. The basin was filled by pumping water from an on-site **pondage**. Quench water that drained from the quenching operation went back into the pondages.

The pondages were part of a larger on-site dam arrangement which drew water from the adjacent creek as required. The pondages and the dam were separated by a semi-porous earth/coke breeze wall which allowed water from the creek dam to flow into the pondage to replenish the water lost as steam. During times of low water flow, additional water was drawn from the nearby town mains supply.

Following completion of quenching the coke was pushed out of the hot car by a blade into a surge hopper which fed on to a conveyor, and weighed by a belt **weightometer.** It then continued by conveyor to the screens, where it was sized and fed into bins ready for despatch by either road or rail [Rail despatch was discontinued in the 1970s].

For over 40 years the coke was hand-quenched and the quenched coke was shovelled into awaiting rail hoppers [Photo 9] on a siding that ran alongside the quench benches. Isolated sections of the **inward and outward tramway / rail siding systems** remain around the site.

The associated infrastructure included an administrative building, truck weighbridge, workshops and a crib room.

4.2 Physical Condition:

There is obvious damage to the operational units resulting from reduced maintenance once it was known the coke-works would be closing, and also damage and disrepair resulting from extensive corrosion, weathering and vandalism since its closure in 2014.

The coke works, in its present condition – Photos 7, 8, 11 still allows for the interpretation of coke-making processes that were carried out over its lifetime.

Many of the battery ovens - C1 [eastern] and C2 [western], have slumped and failed brickwork (Photo 8) caused by heat, and impact associated with the ram and overhead charge car operation is evident - all as a result of normal operations.
Ovens that are selected to be retained will require substantial repairs.

The brickwork of both batteries shows evidence of repair and replacement over time. Each battery charge top remains in reasonable repair. Oven crowns are visible within the cavity beneath the charge car track.

The oven design utilising underfloor flues connecting to underground main flues, allowed obstruction-free traversing of the charge cars and periodic assessment of the crown brickwork. The C1 battery ovens crowns are as originally built.

The waste heat infrastructure has undergone periodic upgrades and remodelling over the life of the coke-works operations.
In the case of C1 battery, the remains of the take-off that diverted the hot waste gases to the Power House boilers from the battery's common main, in 1967, was bricked up and are still visible.
The original waste gas ductwork, the remaining square brick chimney at the end of C1 is in a reasonable condition. However, the 1985 three replacement refractory-lined steel stacks, [one of which replaced three of the 1912 square brick chimney at the north end of C1 battery] show extensive corrosion.

The original 1912 Power House brick chimney, for the main part, is in a reasonable condition - Photo 2.

Oven hoods, uptakes and ductwork which capture emissions that were constructed in 1999 are prominent features of the site and are in a reasonable condition.

There has been a noticeable loss to the integrity of structural elements of the three conveyor gantries including the cladding, several storage bins, quench tower. steel stacks and the rail system are in reasonable condition.

The ram car that was transferred from the Unanderra coke-works is in a restorable condition.

In its present condition there is no trouble for the interested viewer to interpret the coke-works origins and functions.

Comment.
Because the author was denied access to the site, reliance on the physical condition of the site has had to be made on Wollongong City Council reports, the Biosis report, the recollections of several people who worked at the coke-works and a video taken when the site was illegally accessed to interpret of the current physical state of the coke-works which may not be a true representation of the current state of the once operational elements.

4.3 Modifications and Upgrades

Modifications and upgrades to the coke-works are as follows.
The dates of these modifications and upgrades as well as changes in operating practices is given in Appendix 1

- improving the circulation of the hot gases of combustion so to increase the coal charge and coke output
- installation and operation of bag houses on charge cars to virtually eliminate all charging emissions
- installation of collection hoods over the discharge doors of each coke oven to collect and separate particulate emissions while each oven is pushed
- installation of quench towers and fast quenching to reduce particulate emissions
- flat-bed hot cars to minimise coke bed disturbance and reduce emissions before quenching
- road delivery of coal with of an efficient truck wash for all commercial vehicles exiting the site
- concrete and bitumen sealing of all operational areas with periodic wash downs to reduce dust emissions

- construction of bunded coke stockpile areas and sealed internal roadways to minimise dust emissions
- grassing and landscaping or all non-operational areas
- replacing clay sealed doors with self-sealing doors,
- upgrades to automation, power and control systems

4.4 Map of the Site Showing the Assessed Heritage Significance

A five-tier system ranging from *Exceptional to Intrusive* was adopted by BIOSIS in its report [Ref 1] as shown in the following drawing, to assess the heritage elements.

Exceptional: Rare or outstanding element directly contributing to an item of local or State listing

High: High degree of original fabric.
Demonstrates a key element of the item's significance.
Alterations do not detract from its significance

Moderate: Altered or modified elements.
Elements with little heritage value, but which contribute to the overall significance of the item

Little: Alterations detract from significance. Difficult to interpret

Intrusive: Damaging to the item's heritage

4.5 Items of Considered to be of Engineering Heritage Significance

In the Illawarra Mercury of 16 May and 6 September 2020 the Illawarra Coke Company Pty Ltd gave the following undertakings:

The transformation of Corrimal Coke Works from a derelict industrial site into a vibrant new residential community will celebrate its heritage features and rich human stories. A heritage precinct next to Corrimal Station will be the centrepiece where people connect to Corrimal's rich industrial history.

Some of the many ways the Corrimal Coke Works will celebrate its heritage include:

- Preserving the iconic 1912 brick chimney and a second steel chimney to retain these distinctive landmarks in the local skyline
- Retaining and interpreting parts of the original C1 coke oven battery to demonstrate the coke making process
- Adaptively re-using the former powerhouse building
- Creating interpretive displays throughout that share its stories and recognise key historical figures
- Maintaining key view corridors to heritage features so they are integral to the future character of the site.

This undertaking is in line with Wollongong City Council's Minutes of its Ordinary Meeting of 20th October 2020 and Council's listed items of Local Significance.

The author and community action groups, from an engineering heritage significance, see the retention of the 1912 brick chimney, a number of ovens [most likely to be completely rebuilt with new foundations], the ram and interpretive signage as being necessary to tell the story of these coke-works.

Figure 94 - Former Coke Works Significance Map - Detail

5. Location of Former Corrimal Coke Works

The site of the former Corrimal Coke Works is outlined in red.

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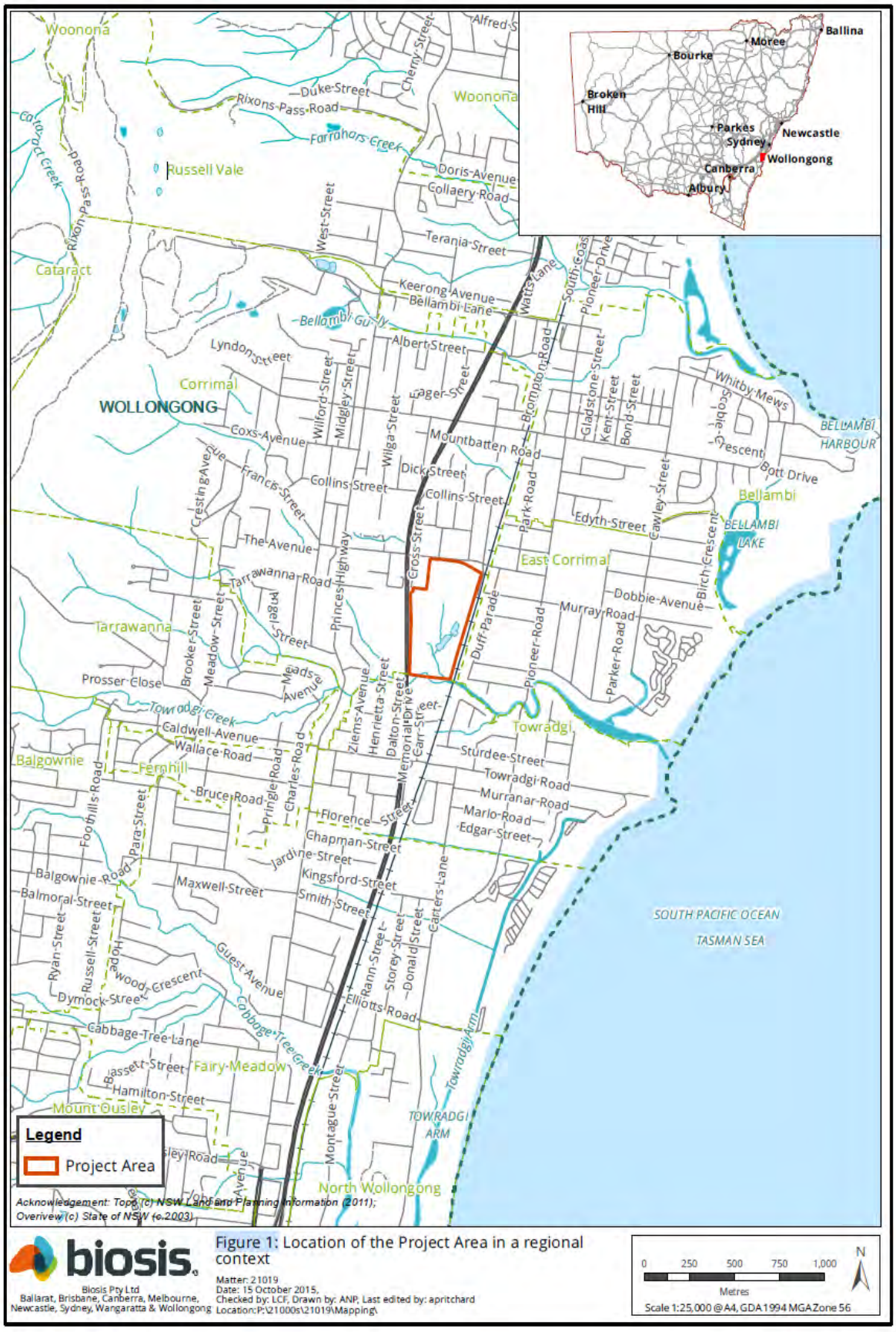


biosis

Biosis Pty Ltd
Ballarat, Brisbane, Canberra, Melbourne, Newcastle, Sydney, Wangaratta & Wollongong

Figure 1: Location of the Project Area in a regional context

Matter: 21019
Date: 15 October 2015.
Checked by: LCF, Drawn by: ANP, Last edited by: apritchard
Location:P:\21000s\21019\Mapping\

6. Background History

6.1 Background Technology

[Refer to Appendix 6 for further technical information]

As a prelude to the '*Industrial Age'* the source of heat to smelt mineral ores to produce metal for founding and for blacksmithing was charcoal, obtained by heating wood in a reduced oxygen atmosphere. As the need for such metals grew, it could not be met by the charcoal producers due to declining supplies of suitable trees, and so by necessity, coke, a far superior fuel, replaced charcoal in the smelting process.

The decision to now use coke in lieu of charcoal as the reduction agent provided a number of additional benefits: -

- coke had a higher crushing strength which allowed more air to circulate in the burden and led to better extraction of the metal from the parent ore. This in turn led to the use of taller and larger blast furnaces which again in turn produced more metal at a cheaper price.
- coke provided a higher operating temperature environment.
- the ratio of coke to ore at the time, allowed more ore to be smelted to a given quantity of coke compared to charcoal.

At the time there was an inexhaustible supply of easily won No 1 seam coal but not always of the most suitable quality.

Primitive forms of beehive ovens have been known since the 16th century. In the late 18th century, brick bee-hive ovens were developed, that allowed more control of the coking process.

Over the 19th century leading into the 20th century a major use for coal was for steam raising where the coal was fired in grate-type boilers. The downside was that coal fines clogged the grates from the accumulation of slag from ash which resulted in inefficient combustion of the coal and grates had to be regularly cleaned. To avoid this problem the fines were screened out at the mine site.

The fines were not a saleable product and consequently, large heaps of fines accumulated around the mine sites or were dumped nearby.

Entrepreneurs saw a use of the fines – also known as duff or slack, as a business opportunity to produce the much-needed coke supplies. However, not all coals were suitable or able to produce coke. This led to the industrialization of the production of coke in purpose-designed coke ovens. *Refer to Appendix 6 for the development of coke ovens*

6.2 Background History of the Corrimal Coke Works

Appendix 1 gives a time-line history and Appendix 2 gives a detailed history of the Corrimal Coke Works

From 1875 a number of metallurgical coke-works had been set up in the Illawarra.
By 1907, Wollongong was the centre of the state's metallurgical coke industry, with towards 500 ovens producing 83% of the state's total coke output.
The Corrimal Coke Works was one of the many coke-works that grew up in association with Illawarra collieries to meet the needs of local, interstate and overseas industries that required this premium product for its continued operations. [Refer Appendix 7]
The coke produced was strong and abrasion resistant, which made it suitable for transportation to foundries and smelters at sites outside the Illawarra.

The Southern Coal Company [SCC], trading as Australian Coke Making Company, established a coke-making works consisting of a battery of 36 old-design beehive type ovens – later increased to 92 ovens, at Unanderra.

In 1890 the Southern Coal Company bought the Bertram's Brookers Nose Colliery renamed it Corrimal Colliery and in 1910 started the process of relocating its coke making business to Corrimal with the construction a new coke-works.

This new coke-works - Corrimal-Balgownie Coke Works, was connected to the mine using the existing incline rail system. At a later date this tramway was connected to the NSW Government Railway at Corrimal Station.

By selecting a green-field site to construct the new coke-works the opportunity was taken to build an coke-making facility that incorporated the best technology of the day; it would include the latest labour-saving devices and be '*one of the most up-to-date in Australia'* and *'second to none in the Commonwealth'* [(4)]
The site would be powered by electricity generated on-site, and include mechanised charging of coal and discharging of coke, from the ovens.

The design for the ovens was based on the US Thomas-type oven [(5)] modified to dispense with the provision of individual oven chimneys. Each oven would incorporate internal side flues to a more efficiently distribute of heat of combustion to the coal/coke bed. [Later in the 1970s bottom flues. Were added}

Instead of the previously-known arrangement with chimneys located on the roof of each oven, the burnt hot waste gases produced by the ovens during the coking process were to be drawn away by a draught created by chimneys, located at each end of the battery, into a common duct to be expelled to atmosphere.

It was the intention that the battery's hot waste gases would be used to meet the electrical power needs for the coke-works and the parent Corrimal-Balgownie Colliery. To achieve this, the hot burnt waste gases and any remaining unburnt gases and volatiles that were drawn into the common duct by the two chimneys, could be drawn off at a point along the common duct into another refractory lined duct that ran to the Power House boilers to raise steam to drive an installed power generating system. Where not used for this purpose, the exhausted gases were expelled to atmosphere.

Corrimal would be the first coke-works in New South Wales designed to recover the waste heat and use it to generate power for its own use.

Between 1911 and 1912 The Corrimal - Balgownie Collieries Limited [The Southern Coal Company changed its name in 1889] erected a battery of 40 coke ovens [C1 Battery]. The estimated cost for the turn-key project was £20,531 [$41,062].

Each oven had an arched roof, a rectangular hearth and parallel side walls. The oven doors – one on each end to facilitate withdrawal of the coke from the ovens, were operated hydraulically.
The locally manufactured refractories were of semi-fireclay which it was believed would give a longer life than bricks made of pure fireclay.

The internal dimensions of each oven were 30ft [9.14m] long, 6 ft 7 ½ in [2.01m] wide and 6 ft 6 in [1.98m] high.

(4) South Coast Times and Wollongong Argus 6 September 1912

(5) Comment:
The Thomas type longitudinal non-recovery coke oven was designed by Samuel Thomas founder of the Pioneer Mining and Manufacturing Company in Birmingham Alabama. The company built a battery of 910 ovens of this design at the rear of its furnace plant to supply its iron-making operations with coke.
The Thomas type ovens were an improvement of the Belgian type rectangular hearth ovens that were relatively efficient, cheap to construct and used unskilled labour in its operation.
The so called [mis-named] bee-hive ovens were built to a variety of patented patterns, the main difference between other types of coke ovens was the internal flue arrangement in the design of the ovens. More information is given in Appendix 5

Each oven incorporated three charge holes in the roof to facilitate self-levelling of the coal bed to promote even heating and carbonization of the coal. However, it did not achieve this outcome. [Levelling of the coal bed using a leveller bar operated from the ram were introduced at a later date.]

The intended process was for the coal to be charged into the coke ovens from an electrically-driven charge car that ran along the battery roof on a four-rail system powered from an overhead collector system. The charge car/ cannister incorporated three hoppers that contained sufficient coal to charge an oven. In operation, the charge car would be driven to the appointed oven, lift the three cast-iron lids covering the charge holes magnetically, charge the oven with the pulverised coal, and replace the lid, sealing the oven.

On completion of the coking process an electrically operated ram would push the red-hot coke out of the ovens onto a quenching hearth to be cooled by men using hand-held hoses.
Once the coke had cooled it was shovelled into barrows and wheeled to railway trucks shunted into a spur line siding, whose railway track was depressed below the apron level to facilitate manual loading. [Photo 9] [It is also possible a rubber belt scraper was used for loading].

The construction of the coke works was to be carried out by day-labour and, where cost effective, local suppliers and resources would be used - e.g., refractory bricks for the lining of the ovens and ducts, bricks for the chimneys and buildings and slag for concrete aggregate from Electrolytic Refining & Smelting Co. of Australia, that was set up in Port Kembla in 1907.

Each oven was capable of taking a charge of 13 tons of fine coal three times a week [(6)] .
By way of example, a burning period for an oven with a charge of 12 tonnes [coal bed thickness ~1.2m] was 3 days and with a charge of 13 tonnes [coal bed thickness ~1.4m] 4 days.

Oven doors were to be operated by chains connected to each door that ran up to a supported steel wire running along the battery top. The procedure being, the selected oven door chain was clamped to this wire and the wire was pulled or released by a ram located at the end of the battery thus raising or lowering the door.

The Corrimal Coke Works, which was reportedly capable of turning out 760 tons/week *[39,000* tonnes per annum] Ref 16. Commissioning trials commenced in May 1912 and official opening was held later on 5 September 1912 when the coke-works had gone into full production.

Comment: Extracts from newspaper articles of the day appear in Appendix 2

In 1916 the Corrimal Coke Works - apart from the Broken Hill Proprietary Newcastle Steel Works and Hoskins Wongawilli Coke Works, were the only coke works in NSW at which all the steam power required was obtained by directing the hot burnt waste gases generated in the coke ovens to the boilers.

In operation it was found that the coke-works generated electricity surplus to its needs and that of Corrimal Colliery. In 1918 the Company sold this excess electricity for domestic and council use in the area covered by the North Illawarra Municipality. This franchise was continued until 1949 when the undertaking was taken over by Greater Wollongong Council and later by the Illawarra County Council. Bulk electricity continued to be supplied from the coke-works until 1966 when the Power House was closed down.

On Friday 17 July 1925 it was reported the excess electricity generated by the Corrimal Power House powered 400 street lamps in the North Illawarra Municipality.

To meet increasing demand for electrical power, in the early 1930s:

- the original C1 battery was extended to the north by the addition of ten more ovens to make a total of fifty ovens
- the Power House equipment was upgraded with the addition of a 1,000KW turbo alternator unit

(6) The advised oven coal charge and cycle time varies as required

- the Power House boilers were replaced.

In 1947 the four Illawarra municipal areas combined to form the City of Greater Wollongong, and in 1948 the new council purchased the Corrimal Coke Works electricity franchise for a fee of £30,000.

By the late 1950s construction began on a new oven battery (C2) with 32 ovens of similar design to C1 battery ovens but larger in capacity. While these ovens were essentially the same design of the C1 ovens they did not provide for the recovery of the heat from the burnt waste gases for power generation purposes.

At this time, the old 1500-ton timber coal storage bunker at the southern end of C1 battery was replaced by steel hoppers.

In 1960 the continuing growth of the plant demanded more power. To meet this demand the Power House was extended to allow for a new 2,000KW 6,600V geared turbo-alternator set, replacement of the control systems and switchgear. To provide additional steam for the generating plant, two fire-tube boilers designed to be operated as coal-fired, waste gas-fired, or mixed coal/waste gas-fired, were installed to replace the existing boilers. They were fully automatic in operation when on waste gas firing, and semi-automatic when on coal or coal/waste gas operation.

The new battery C2 was commissioned in July 1962.

1964 saw the purchase of Corrimal Colliery by Australian Iron & Steel.
Both AIS and Illawarra County Council no longer wanted the coke-works to supply power. As a consequence, the Power House was shut down and its plant sold off. Power now was supplied to the works by the local County Council.

In 1969 ownership of the coke-works changed again with its purchase by Bellambi Coal Company.

Over the next twenty years, the Bellambi Coal Company spent over $2M installing pollution reduction equipment in order to comply with new environmental legislation and meet community expectations. The additions and modifications included:

- incorporating bag houses on the charge cars[to reduce the fugitive emissions from the time the lids were lifted through the charging and levelling of the coal charge in the oven to the replacement of the lids; referred to as ‘smokeless charging’.]
- Quench towers which incorporated emission capture and removal of grit from stack emissions;
- Control of oven emissions by replacement of three of the old brick chimneys and new steel refractory lined flues;
- Addition of baghouses on the charge cars for clean air charging which virtually eliminated all charging emissions.
- Concreting and sealing of all production areas to reduce dust emissions and facilitate wash down
- installation of collection hoods over the discharge doors of each coke oven to collect and separate particulate emissions while each oven is pushed
- Installation of flatbed hot cars to minimise coke bed disturbance and reduce emissions during pushing and transfer tore quenching
- Installation of an efficient truck wash for all commercial vehicles exiting the site
- Construction of bunded coke stockpile areas and sealed internal roadways to minimise dust emissions
- Grassing and landscaping of all non-operational areas

The Bellambi Coal Company was taken over by Australian Coal and Coke Pty Ltd in 1980 and from 1982, the works was upgraded and activities progressively automated.

Another change in ownership occurred just four years later when in 1984, Kembla Coal and Coke Pty Limited's subsidiary the Illawarra Coke Company [ICC] purchased the coke-works to add to its operation at Coalcliff.
With this purchase Kembla Coal and Coke became the largest producer of foundry coke in Australia.

Illawarra Coke Company Holdings Pty Ltd (a private company) purchased ICC in 1996 becoming the only independently owned producer of coke in Australia.

In late 2013 the owners announced that the Corrimal Coke Works was to close permanently by April 2014. This decision was attributed to negative market conditions that resulted in an excess of coke worldwide. Because of the substantially reduced demand, the small private Illawarra Coke Company was no longer a viable business.

When it closed in 2014, the Corrimal Coke Works had provided the Illawarra with a continuous source of permanent employment for over 100 years and was, at that time, was arguably the oldest coke-making facility to be in continuous operation in the world.

7. ASSESSMENT OF SIGNIFICANCE

7.1 Historic Phase:

The former Corrimal Coke Works is significant because:

- The site was in continuous operation from its construction in 1912 until its closure in 2014. It operated in close association with Corrimal Colliery, a significant coal mine in the Illawarra.
- It was the longest continually metallurgical coke-producing works in Australia and arguably, in the world.
- It is a visual reminder of the part that coke-making played in the coal mining, smelting, founding and steel-making industries, which were highly important to the development of the Illawarra and historically significant industries at state and national levels.
- The site contains elements of the original 1890, 4ft 8 ½ in gauge tramway that linked the colliery and later Corrimal Coke Works, to the South Coast railway.

7.2 Association with Historic Individuals:

The former Corrimal Coke Works has no significance in this area.

7.3 Creative or Technical Achievement:

The former Corrimal Coke Works is significant from a technical perspective because:

- It was a contributor to the development of the metallurgical coke, smelting, founding and iron manufacturing industry in Australia, particularly in the Illawarra region with the production of high-grade metallurgical coke that proved to be superior in strength and abrasion resistance to most metallurgical coke produced elsewhere in Australia and abroad.
- At the time of its commencement, it was reportedly the most modern coke-works in Australia.
- It was the first coke works in NSW designed to recover the waste heat and use it in boilers to raise steam to generate electricity.
- It generated its own electric power from 1912 and from 1918 the excess electricity was supplied to the local municipality for street lights and domestic use, until the mid-1960s

7.4 Research Potential:

The former Corrimal Coke Works is significant because:

- The coke works was established at a time of advancement and modernisation in the design and construction of coke-making and when many batteries were developed in Australia. Corrimal Coke Works was at the forefront in adopting modern designs, and did so over the 102 years it operated.
- The site was previously linked by a 4ft 8 ½ in standard gauge tramway (of which some of tracks still exist), to the escarpment Corrimal Colliery which closed in 1985. This linkage has research potential.
- The continuous use of the site for over 100 years has created multiple layers of industrial fabric and social history.

7.5 Social:

The former Corrimal Coke Works is significant because:

- Together with the Corrimal Colliery it played a key part in the establishment of Corrimal as a suburb and ensured the economic health of the locality as a continuous employer of multiple generations of local families, and it generated employment in peripheral local industries

- Utilising waste gases from coke-making, it generated electrical power for its own use and supplied its excess power locally for domestic use, and to the local council for street lighting.

- It is significant to historians and researchers of the social history of the Illawarra.

- The stacks, chimneys and the Power House are important landmark reminders of industry that once dotted the Australian and Illawarra industrial landscape.

7.6 Aesthetic

The former Corrimal Coke Works has limited significance from an aesthetic perspective.

7.7 Representativeness:

The former Corrimal Coke Works is of representative significance because:

- Together, with the Coalcliff Coke Works, the Corrimal Coke Works are the remaining representatives of over 500 rectangular beehive-type coke ovens located in a number of coke-works in NSW, and of more than 300 rectangular beehive-type ovens built in Queensland and other states, that operated from 1853 to 2016.

- The Corrimal Coke Works is representative of the 14 metallurgical and “town gas-making’ coke works built in the Illawarra, and others elsewhere in Australia.

7.8 Integrity and Intactness:

The former Corrimal Coke Works is of significance in this area because:

- Essentially, it remains in the condition when it ceased operation, although many of the elements such as the interior brickwork of the 1912 coke ovens has deteriorated due to over a century of continuous use.

7.9 Rarity:

The former Corrimal Coke Works has rarity value because:

- As shown in Appendix 6, almost all coke ovens in the Australia have been removed and their heritage value reduced to that presented by archaeological evidence.

- It is one of the two coke works remaining from the formative period of Australia’s industrial history.

Of the fourteen coke works built in the Illawarra and the many others that were built elsewhere in Australia, only the Corrimal Coke Works and Coalcliff Coke Works remain in a substantially intact condition.
The Queensland government has called tenders for the demolition of the Bowen Coke-Works, the only other rectangular beehive oven coke works existing in Australia

7.10 Statement of Significance:

The former Corrimal Coke Works operated from 1912 to 2014; it was the longest continually metallurgical coke-producing works in Australia, and was a significant contributor in the development of the Australian coke, steel and smelting industries.

It was also the first in NSW designed to recover waste heat to raise steam for electricity generation. From 1918 to 1964 its electricity powered the works with the excess electricity, up to 1948, supplying local domestic users and municipal street lighting.

With the Corrimal Colliery it played a key part in the establishment of Corrimal as a suburb and ensured the economic health of the locality as a continuous employer of multiple generations of local families; as well, it generated employment in peripheral local industries.

The Corrimal Coke Works is representative of the 14 metallurgical and town-gas-making coke works built in the Illawarra, and others elsewhere in Australia.

Its stacks, chimneys, ovens and Power House are important landmark reminders of industry that once dotted the Illawarra landscape.

7.11 Comparisons:

From the 19th century the Illawarra was Australia's major coke producing region. It is a sad fact that most of the coke-works – both metallurgical and domestic gas production, that were constructed in the Illawarra and elsewhere in Australia, have been demolished leaving little evidence of their once operational presence.

The remaining oven sites of rectangular beehive-design derivation, include the Corrimal site and the Illawarra Coke Pty Ltd coke-works at Coalcliff [where the ovens were rebuilt in the 1960s] and Bowen Coke Works in Queensland.

The remaining slot-type by-product recovery ovens are located at BlueScope Steel Port Kembla steelworks [its oldest surviving coke oven battery was built in 1966] and those at Liberty Steel Whyalla steelworks in South Australia.

A list of known coke works producing metallurgical and foundry coke in NSW in 1916, is given in Appendix 6

There are five other sites that have been used for comparative assessment purposes:

G & C Hoskins Limited, Lithgow, NSW
Commonwealth Oil Company, Wolgan Valley NSW
Osborne & Ahern's Coke Works, Wollongong NSW
Illawarra Coke Company Pty Ltd, Coal Cliff, NSW
Glencore Bowen Coke Works, Bowen Qld

Refer to Appendix 3 for comparisons

7.13 Listings:

The Corrimal Coke Works is listed on:

- The NSW State Heritage Register as having been the subject of a 'Heritage Act - Authorised Interim Heritage Order', Listing Number LC-2. Database Number 5067133
- The National Trust (NSW) Register.

Wollongong City Council has:

- Added the former Corrimal Coke Works site to Schedule 5 of the Wollongong Local Environmental Plan 2009
- Added the former Corrimal Coke Works site to the Wollongong Local Environmental Plan 2009 Heritage Map, showing heritage items within the area.

8. INTERPRETATION

8.1 Suggested Site for Placement of a Recognition & Interpretation Panel

It is proposed that initially the site be accorded virtual recognition. At a later date, should the owner or the Owners Corporation of the complex agree to have a commemorative plaque or an interpretive panel that explains:

- The coke making process that was carried out on the site over the years of its operation, and
- The history of Corrimal Coke Works,

the wording, size and placement of a recognition panel would be subject to agreement of the parties involved which would include Wollongong City Council.

8.2 Suggested Panel Wording

If it eventuates that agreement is reached to instal an interpretive panel at the site, text along the following lines should be included on the panel:

Former Corrimal Coke Works

These coke works were a significant contributor to the development of the Australian coke, steel and smelting industries, in particular to the Illawarra region. The works were in operation between 1912 and 2014 producing high quality metallurgical and foundry coke.
It was the longest continuously operating coke-works in Australia, and arguably the world,

The Institution of Engineers Australia,
202?

9. REFERENCES & ACKNOWLEDGEMENTS:

This submission used information from the following publications, letters DVDs and web-sites:

	Author	Title	Publisher	Repository/ location	Year
1	Biosis Pty Ltd	Corrimal Coke works, Corrimal NSW – Historical Heritage Assessment		Wollongong City Council Library	2017
2	Don Reynolds	Coke Making in the Illawarra	Illawarra Historical Society	Wollongong City Council Library	2006
3	High Ground Consulting	Archeological Management Plan for the G and C Hoskins Ltd Coke Ovens Ruins Lithgow			
4	Bob McKillop	Furnace, Fire and Forge Lithgow's Iron and Steel Industry 1874 - 1932	Light Railway Research Society of Australia Inc	Wollongong City Council Library	2006
5	Brian Rogers	The Coke Works on Flagstaff Point, Wollongong1875 - 1890	Australian Journal of Archaeology Vol 6	Wollongong City Council Library	1988
6		Corrimal Coke works Centenary 100 Years of coke making		Wollongong City Council Library	2012
7	AISCE Steel Foundation	Manufacture of Metallurgical Coke and Recovery of Coal Chemicals		http://patron.group/wp-content/uploads/2018/08	1999
8		Assessing Heritage Significance			2001
9	Metallurgical Society of AIME	History of Iron and Steelmaking in the United States	American Institute of Mining, Metallurgy and Petroleum Engineers Ir	https://ethw.org/w/images/9/99/The_History_of_Iron_and_Steelmaking_in_the_United_States.pdf	1961
10	NSW Dept Mines	Report N0. 23 The Coke Industry of NSW	NSW Government Printer		1916

Web sites

11	Illawarra Heritage Trail: Corrimal Coke Works	http://www.illawarra-heritage -trail.com.au/index.php/sites/ coke works-composite/corrimal-coke-works
12	Illawarra Coke *Noel Leeder* coke making process	https://www.youtube.com/watch?v=1ZMxW5UKRFAA
13	Report on the manufacture of Cokes	https://books.google.com.au/books?id=LG0_AQAAMAAJ&pg=PA112&lpg=PA112&dq=newcastle+area+coke+works&source=bl&ots=w7_DpJlf-6&sig=ACfU
14	Thomas furnaces	https://www.bhamwiki.com/w/Thomas_Furnaces
15	Republic Steel Corporation Thomas By-product Coke Works Birmingham Alabama	https://www.google.com/search?rlz=1C1CHBF_en-GBAU826AU828&sxsrf=ALeKk02nN_QutW6-i1ZDi5iNz6LhI86PRQ:1594251838398&source=univ&tbm=isch&q=Republic+Steel+Thomas+byproduct+works&sa=X&ved=2ahUKEwjgkor06r7qAhUQ4zgGHXM7C7gQsAR6BAgGEAE&biw=1280&bih=610&dpr=1.5
16	Department of Mines The Coke Industry of NSW No 23 1916	https://archive.org/stream/cokeindustryofne23harp/cokeindustryofne23harp_djvu.txt#:~:text=In%201877%2C%20coke%20ovens%20were%20erected%20by%20the,greatly%20improved%2C%20and%20the%20number%20of%20ovens%20increased.

The author's research on the former Corrimal Coke Works has benefited from the knowledge and experience of a number of people – Paul Lucas, Neil Newman and Syd Webb and in particular Ian Sheppard, among others to whom I owe a debt of thanks. My particular thanks are given to Michael Clarke who again has been generous with his time to review and use his editing skills to improve the text of the document.

The author has drawn on the information on the Wollongong City Council's website, Trove and Google websites and information collected by members of the Corrimal Community Action Group in their campaign to prevent the overdevelopment of the former Corrimal Coke-works site from various websites. The material obtained from the noted references and these sources has, to some extent, been rewritten and incorporated into this document.

Appendix 1 History Time Line of Former Corrimal Coke Works

Date	Event	Comment
1884	Thomas Bertram opened Brokers Nose Coal Company colliery	
1885	Bertram erected 7 bee-hive ovens of Harrison's patent down from his colliery at Brokers Nose	The ovens operated sporadically and by 1890 were out of use
1888	Southern Coal Company [SCC] formed in the UK to build a colliery at Mt Kembla, a railway from the mine to a new jetty at now Port Kembla	
1888	SCC Australian Coke Making Company erected the predecessor of Corrimal Coke Works -initially 36 ovens later increase to 100 beehive ovens. In 1890 the works with 24 ovens it was turning out 200 tons per week. Predicted with 36 ovens the output would be 300 tons per week.	This was the first coke-works to produce coke on a viable commercial scale The weekly production was 400 tons
1888	SCC My Kembla mine ran into geological trouble and leased Thomas Bertram's coal mining and railway facilities	SCC closed down Bertram's small coke works.
1889	Brokers Nose Coal Company Brokers Nose Colliery was bought out by the G S Yuill's Corrimal Coal Company	Colliery renamed Corrimal Colliery
1902	Southern Coal Company reconstituted as Corrimal-Balgownie Collieries Limited	
1911	Intention of G S Yuill to build a modern coke-works at Corrimal was announced after the site was purchased	
6 July 1911	North Illawarra Council approved application for construction of the new coke-works	
1911 - 12	Corrimal Coke Works 40-oven coke works was constructed	Estimated cost £20,531 [$41,062]
May 1912	Operations commenced with the commissioning of the works	
1912	Unanderra coke-works closed down and all reusable plant – including the ram, was relocated to Corrimal	
1912	Output of the coke-works was around 950 tonnes / week Based on the contracts that the Unanderra coke-works serviced the output of coke – domestically, would be going to smelting companies I Broken Hill. Mount Morgan, Chillagoe, Wallaroo and Port Augusta. And for export to San Francisco, Japan and other Eastern ports	Approx. 55,000 tonnes/ year *South Coast Times and Wollongong Argus 8 December 1906*
1912	Over 600 ovens in the Illawarra. Over 75% of coke produced comes from the Illawarra	SMH 18 January 1912 Chief markets Cobar, Lithgow, Port Kembla, Port Pirie, Cockle Creek, Chillagoe, Mount Lyall and export
1916	Reported maximum operating capacity 760 tons/week	Ref 10
1916	The land occupied by the Corrimal coke works was doubled in size by the purchase of adjacent land by G. S Yuill and Company Ltd.	This gave the works its present boundary
1919	The electrical plant at the coke ovens was duplicated	
1919	Electrical power in excess to its needs sold to domestic and municipal customers	
1920	Completion of a large on-site dam connected to Towradgi Creek	
17 July 1925	Electricity generated by Power House was reticulated to the North Illawarra Council area to power over 400 street lamps and domestic power.	CCW owned the distribution network
1930	C1 Battery was extended to the north adding 10 more ovens of the same design.	The battery now contained 50 ovens
1932	1000kW turbo-alternator was installed in the Power House to meet an increased demand for power	
1937	Company became known as Corrimal Coal and Coke Company Pty Ltd. At a later date the coke manufacturing section came under the control of South Coast Coke Pty Ltd	
Dec 1948	Greater Wollongong City Council purchase the Corrimal Coal and Coke Company's electricity franchise to the North Illawarra Council area for £30,000 [$60,000}	
1959	Construction began on a new coke-ovens battery C2 with 32 ovens of a similar design to the C1 battery ovens but with larger capacity ovens –the size of the C1 ovens	Capacity of C2 ovens 1.5 times capacity of C1 ovens Potential output is now over 100,000 tons/ annum
1959	The old 1500-ton timber bunkers that received coal from Corrimal Colliery were replaced with steel hoppers that each had a capacity of 250 tonnes	
1960	A 2,000KW 6,6kV geared turbo-alternator set was installed in and enlarged Power House with modern switchgear. To provide steam for the generating plant, two fire-tube boilers designed to operate as coal fired, waste gas fired or mixed coal/waste gas fired boilers were installed. The Southern chimney remains in place; northern chimney	They were fully automatic in operation when on waste gas firing and semi-automatic when on coal or coal/waste gas operation

	replaced due to deterioration	
July 1962	C2 battery commissioned	
Feb 1964	Australian Iron & Steel purchased Corrimal Coke Works and Corrimal Colliery	The change in ownership meant deliveries of coal were now by road instead of rail from Corrimal Colliery after completion of the underground link between Corrimal and Kemira Colliery.
1967-8	Power House decommissioned and equipment sold and the Power House closed and the boilers and stack removed	
1969	Bellambi Coal Company purchased Corrimal Coke Works	Coal supplies now sourced from South Bulli Mine
1969 - 75	Bellambi Coal Company Limited spent more than $2 million installing pollution reduction equipment including Quench Towers, refractory lined steel stacks C2 North and South	
1977	Smokeless charging of ovens with a baghouse being installed on each charge car	
1980	The Bellambi Coal Company Limited was taken over by Australian Coal & Coke Pty Ltd	
1982 on	The works were upgraded and activities progressively automated	
1984-96	Sealing of production area surfaces so as to wash down these area	
1984	Illawarra Coke Company Pty Ltd a subsidiary of Kembla Coal and Coke [itself a subsidiary of the Broken Hill Associated Smelters Pty Limited purchased the works to add to its operation at Coal Cliff	The purchase now made KCC the largest producer of foundry coke in Australia Coal supplied from Coal Cliff Colliery and later West Cliff Colliery
1985	The C1 North brick smoke stack was replaced with a steel stack	
1996	CCW changed hands again with Illawarra Coke Company Pty Limited being bought out by Illawarra Coke Company Holdings Pty Limited	The combined works became the only independent ly owned producer of coke in Australia
End of 90s	New flues and stacks and the addition of a baghouse on the charge car for clean air charging and a new quench tower canopy to capture low level emissions.	
1999	New oven hoods, uptakes and ductwork installed on both batteries to capture oven pushing emissions	
	Corrimal Coke works is accredited to AS/NZS ISO 9001:2008	
2012	Production now around 35,000 tons annually	
2013	Intention to close the works was announced	
2014	Last push	
2014	Gates closed forever	
4 October 2017	Application made to Wollongong City Council to change the zoning of the site to one that would allow the construction of housing	

Appendix 2 Expanded Early History of the Former Corrimal Coke Works

Early Coke Production in the Illawarra

From 1875 a number of metallurgical coke-works produced coke for the Illawarra region from suitable coal from the Bulli, Balgownie and Wongawilli coal seams, that was readily available, and mined in drift-entry coal mines along the Illawarra escarpment. The coke produced was strong and abrasion resistant, which made it suitable for transportation to foundries and smelters at sites outside the Illawarra. [The Sydney Morning Herald reported on 18 January 1912, p11 that: '*The superiority of Illawarra coke is due to its hardness and it burns with the minimum quantity of ash. Another important factor is that, whereas nearly three tons of coke can be manufactured from Illawarra slack, very little more than two tons can be obtained from a similar quantity of coal from other districts'*].

By 1907, Wollongong was the centre of the state's metallurgical coke industry, with towards 500 ovens producing 83% of the state's total coke output. The Corrimal Coke Works was one of the many coke-works that grew up in association with Illawarra collieries to meet the needs of local, interstate and overseas industries that required this premium product for its continued operations. [Refer Appendix 6]

Southern Coal Company

The parent company of the original Southern Coal Company [SCC] was G.S. Yuill & Company Pty. Ltd trading as Australian Coke Making Company. Its coke-making works was a battery of 36 old-design beehive type ovens, located at Unanderra.

In 1889 the Southern Coal Company transferred its business to Corrimal because:

1. The Unanderra 1888 old-type rectangular bee-hive ovens were not performing well in comparison with other local coke producers in terms of output and labour requirements.
2. The coal fines to feed the Unanderra ovens were being brought from its Corrimal Colliery [which mined the high-quality Bulli Seam] some 15 km distant involving significant cost.
3. Coke oven technology had made significant gains since 1888 both in improved output without a loss of quality and productivity as a result of the mechanization of operations

In a win-win outcome, the coke-works was established near the colliery and connected to it by an incline rail system and tramway. At a later date the colliery was directly connected to the NSW government railway at Corrimal Station.

The New Coke Works at Corrimal

The first reports of a new coke-works for Corrimal appeared in 1910 with the *South Coast Times* reporting: "*Much satisfaction is expressed locally at the commencement of the erection of about thirty ovens for the manufacture of coke by the Corrimal-Balgownie Coal Co. This project has been rumoured for the last couple of years. It will probably be nine months or so before the ovens will be ready for firing. Corrimal is likely yet to justify the prophecy that it is to be the largest town, probably excepting Port Kembla, south of Sydney."*

The first part of the Corrimal site was purchased by the Corrimal Coal Company in 1910, with the proposed site of the coke-works being at the foot of the escarpment, below the Corrimal Colliery. Apart from a few scattered houses and farms, the site was cleared bushland and adjacent to the NSW Government Railway's Corrimal railway station; this gave both the colliery and the coke-works a direct connection for movement of coal and coke by the rail system, and to Port Kembla harbour.

By selecting a green-field site the opportunity was taken to build an integrated coke-making facility that would incorporate the best technology of the day; it would include the latest labour-saving devices and be '*one of the most up-to-date in Australia'* and *'second to none in the Commonwealth'"* [(4)]

Between 1911 and 1912 The Corrimal - Balgownie Collieries Limited [The Southern Coal Company changed its name in 1889] erected a battery of 40 coke ovens [C1 Battery]. The estimated cost for the turn-key project was £20,531 [$41,062].

The construction of the coke works was to be carried out by day-labour and, where cost effective, local suppliers and resources would be used - e.g. refractory bricks for the lining of the ovens and ducts, bricks for the chimneys and buildings and slag for concrete aggregate from Electrolytic Refining & Smelting Co. of Australia, that was set up in Port Kembla in 1907.

It was reported in the *Illawarra Mercury* of 6th September 1912:

The works can be classed as the most up-to-date of the kind in the State, and all the latest labour-saving appliances have been installed, and provision made for turning out a sample of coke that will be without a peer on the market. Electricity is the power used, and it is generated at the works by means of the most modern machinery, and the surplus power is conveyed to the Corrimal mine, where it is used for lighting and haulage purposes. When the slack arrives from the mine at the works it is tipped into a huge storage bin capable of holding 1500 tons, and from here it is conveyed under the railway line to the works by means of an elevator. The ovens are 40 in number, and they differ from those so familiar to residents of the South Coast, owing to the fact that the chimney on top is dispensed with, and one large stack 100 - feet. high, is utilised as a smoke vent for the whole 40 ovens. The heat from the ovens is also utilised for heating the boilers, from which the power is derived. The ram used for ramming the coke out of the ovens is driven by electricity. A railway siding has been constructed at the side of the works to facilitate loading operations. The doors of the ovens are worked by hydraulic power, and the ovens are filled from electrically driven trucks, which run on rails laid along the top. When in full swing the output will be about 650 tons of coke per week

It was further reported in *South Coast Times and Wollongong Argus* Friday 10 May 1912, page 5

Adjoining the railway station premises at Corrimal there now stands a plant of coke ovens, which are to take the place in treating the slack from Corrimal mine, of the plant at Unanderra which was the first of commercial proportions in this district. The ovens are forty in number and are of the Thomas design; they take a charge of 13 tons. The apertures by which, the slack pours from the top into the ovens are so designed as to facilitate distributing the material throughout the oven, the flues to carry the gases to the bottom, and so make an even burn. The 'duff' bin, from whence the slack goes to the ovens, has 21 discharging trap doors, and the charge will be conveyed from these in canisters, each carrying 13 tons to the ovens. There are three of these canisters and they will be hauled by a motor. A Buchanan double-racked ram, operated electrically, will be the means of discharging. In the, construction of the ovens over 250,000 bricks have been used, supplied by the Illawarra Brick and Fireclay Co., the inner bricks are of semi-fireclay, which is considered to be more durable than the pure fireclay. The motor power scheme is an electrical one. The gases of the ovens will pass along a flue to the Babcock and Wilcox water-tube boilers. The engine is a Bellis Morcom, and there is a 400-kilowatt set. A current of 6,600 volts will be developed, of which equal to 500-h.p. will be supplied to the colliery, where it will operate the machinery. All the motor power in use at the coke plant will be electrical. The machines will include two motors of 40-h.p., and three of 15-h.p. each. The gases after heating the boiler, will be carried away to a chimney of 100 feet in height. This has yet to be built, but the foundations of two feet of concrete are laid. In making the concrete slag, from the Port Kembla smelter, has been used. Some fear that a rather serious nuisance of fumes would result from operations was prevalent

when the work was begun, and that visitors would get their first impressions of beautiful Corrimal in the form of a shift of sulphurous and grimy fumes.

The design, however, will reduce that kind of thing to a minimum. The coke when put out will be wheeled (it is intended to apply motor power to the work) to a dock but a few feet away, along which the wagons will draw, and beyond this there are two other docks.
The work of construction has been carried out by the company themselves.

Appendix 3 Coke Production Sequence at Corrimal Coke Works through its Years of Operation:

The production of the coke from coal involved a number of steps to arrive at the end product.
Customers required a strong coke that would not crush and was highly resistant to abrasion.
Coke was produced to specification - small size coke for blast furnaces and large size for foundries.
.
The following is drawn from a circa 1958 company brochure.

Run-of-mine washed coal is transported in company [rail] hoppers on the company's private rail line from the Corrimal Colliery coal preparation plant to the Corrimal Coke Works, about a mile away.
At the coke-works the bottom discharge hoppers were shunted up an elevated timber gantry and the coal was dropped down into a 1500-ton storage bunker [constructed from used railway sleeper timber] below the gantry.
The coal is then fed by a scraper elevator into a Carr crusher for reduction to slack size.
The fine coal is then transferred by conveyor to the C1 battery Fine Coal Bin. The fine coal for the C2 battery is transferred by a cross conveyor from the C1 bin to the C2 bin located at the end of the C2 battery.
When required, the fine coal is charged into the charge car's three cannisters [hoppers] and the electrically driven charge car travels to the appointed oven on a set of rails which run above the battery and discharge the coal into the oven through three openings in the roof. The coke ovens are of the "Thomas" beehive type, measuring 30 feet long, 6ft 7 ½ in wide and 6ft 6in high. The two doors of each oven are hydraulically operated.
Fifty ovens are in use, and the burning periods are seventy-two hours and ninety-six hours, according to the size of the charge [12 tons and 14 tons respectively].
At the completion of the campaign the coke is pushed out of the ovens by an electrically operated ram onto the quenching hearth to cool the coke and stop further combustion.
The coke is quenched using water drawn from a large on-site dam by men using hoses.
Front end loaders pick up the quenched coke from the hearth, transferring it to a scraper conveyor, from which the coke is elevated by a rubber belt conveyor into a screening and sizing plant.

Apart from the press articles, there is no clear information on how the works operated when it was first built. It is likely there were no conveyor belts and handling of coal and coke was done manually up until conveyors were installed in the 1930s??.and after that as described above.

A 1964 Company brochure describes the current operating sequence as follows:-

Coal from Corrimal Colliery by either road or rail to the coke-works where it is discharged into the bunker. It is then prepared for coking in a modern crusher which reduces it to an optimum coking size. Crushed coal is then transferred by bucket elevator to the 200 tons capacity fine coal bins for delivery into a coke oven charge car. The electrically operated car runs on rails laid over the top of the ovens which are charged with fine coal through charge holes situated on the dome of each oven. Charge holes are then sealed by cast iron removable lids.
After charging, coal is levelled by a mechanical levelling boom attached to the coke oven ram.
At the start of the coking cycle, the coal charge is quickly heated by residual heat in the oven brickwork from the previous charge – approximately 500 to 550^0 C. This heat commences to drive off the volatiles in the coal, which ignites and begins to re-heat the oven reaching a temperature of about 1100 to 1200^0 C. Initial heating of the coal and firing of the volatiles takes about half an

hour, after which the temperature of the burning gases within the oven quickly reaches approximately 1000^0 C. steadily increasing to the maximum of 1200^0 C. which is attained about 8 hours before the coking cycle is completed.
On completion of the cycle, the coke is pushed from the oven for quenching, cooling and storage After quenching, coke is loaded from the hearth by front end loaders on to a 36in double-headed flight conveyors - each 150ft between centres.
Coke is discharged from these conveyors through a fixed bar grizzly on to a 36in wide rubber conveyor belt that delivers the unscreened coke to a Vibro-King triple deck screen.
The screens are set at an angle specifically designed to prevent cascading of the coke, with resultant inefficient sizing. Each screen deck feeds into a separate hopper which are maintained near capacity to prevent degradation of size after screening.
The three surge bins of 40 tons capacity are provided for direct loading to rail or road transport, as well as a substantial storage area.
Waste gas flues for power generation have been provided on both sets of battery ovens.
Initially, generation of power was based on boilers designed primarily for use with hand-fired coal under natural draught, but arranged so that they could be operated as waste heat boilers using heat available from the original set of ovens.
With the growth of the company's demand for power, the existing plant, which was last augmented in 1932 by the addition of a 1,000KW turbo-alternator, was again increased in size during 1960. A 2,000KW. 6.6KV geared turbo-alternator set was installed in an enlarged power house together with new and more modern switchgear.
To provide steam for this generating plant, two fire tube boilers designed to operate as coal-fired, waste gas-fired or mixed coal/waste gas fired boilers were installed. They are fully automatic in operation when on waste gas firing and semi-automatic when on coal or coal/waste gas operation.
The boiler plant is arranged so that by a system of brick flues and a stack controlled by a water-cooled damper, a constant draught is maintained on the ovens to provide optimum coking conditions.

It is thought that this system operated until the environmental driven makeover of the coke handling system in the 60s when the quench towers were installed, hot cars replaced the quenched coke carrying conveyors and the coke was now directly pushed into the cars.
The operation of the coke-works was basically now as described in 4.1

Coal Supply

From the start of operations in 1912 coal was provided from Corrimal Colliery.

In 1964 to provide more coal for its operations at Port Kemba steelworks, Australian Iron and Steel Pty Ltd [BHP] purchased both Corrimal Colliery and Corrimal Coke Works.
For a short time, following BHP's purchase of Corrimal Colliery coal continued to be supplied from this source until BHP required all production to go to its Port Kembla steelworks.

In 1969 ownership of the coke-works changed again with its purchase by Bellambi Coal Company. It now sourced its coal from the Bulli Seam at the South Bulli Mine.

South Bulli Colliery closed in 1985 and the coke-works was now supplied by Coalcliff Colliery which also mined the Bulli Seam.
Since closure of Coal Cliff Mine in 1990, the coke-works used Bulli seam coal from West Cliff and Metropolitan Collieries (both deep shaft/drift mines) until closure. Apparently, a blend of these coals gave the best coke.
.

Shift Patterns

From its commissioning day, Corrimal coke-works basically worked day shift Monday to Friday. One operator worked Monday to Friday afternoon shift, plus a four-hour overtime shift during the day on Saturday and Sunday to check and adjust oven temperatures and coking rates by adjusting air admission into ovens during their cycle.
There were different arrangements for Public Holidays.

The ovens were operated on a 3 +4-day cycle [Monday/ Thursday and Tuesday/ Friday] with alternate ovens pushed on successive days.
Pushing alternate ovens i.e. all the odd number ovens on a Monday and Thursday and even numbered ovens on a Tuesday and Friday and charging on the same day as the ovens were pushed maintained More even and higher average battery temperatures. It did not overload the main flue systems with volatile matter, resulting in incomplete combustion and excessive smoke and particulate emissions. Also, it did not overheat the flues and chimneys/ stacks, due to the combustion of excess residual volatiles in these areas.
[Maximum release of volatiles occurred 24 hours, reducing as the coking process continued.]

Appendix 4 Images of Corrimal Coke Works and Coke-making

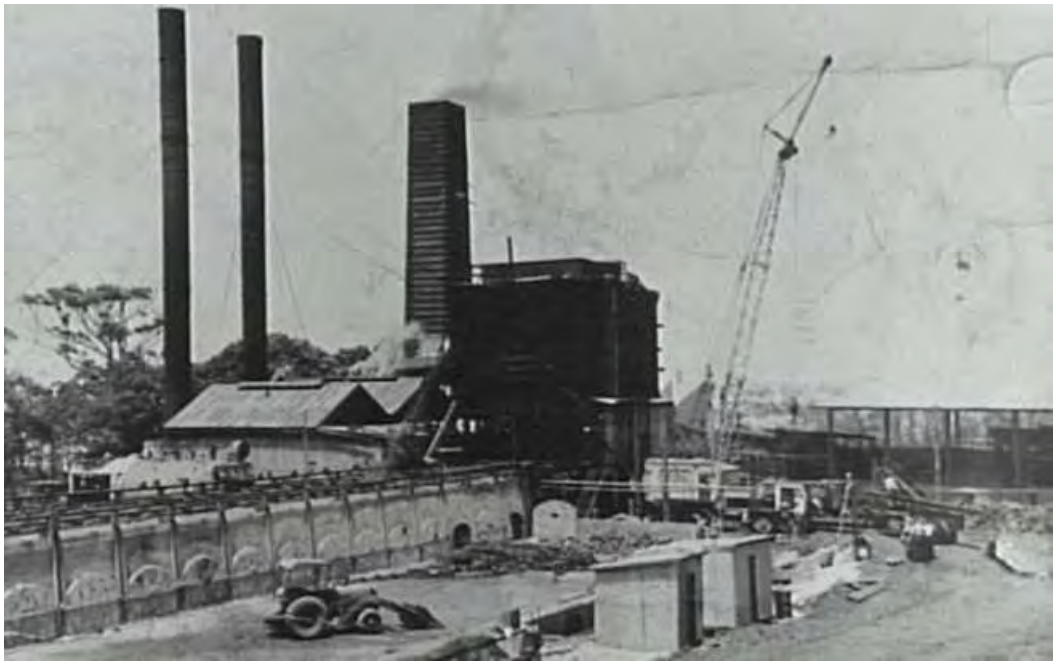


Photo 1. Corrimal Coke Works showing C1 and C2 Batteries, two steel power house and one brick stacks, powerhouse and fine coal bin. ~1959 source Wollongong City Council

Photo 2. 1912 Brick Chimney 2019 *source Ref 1*

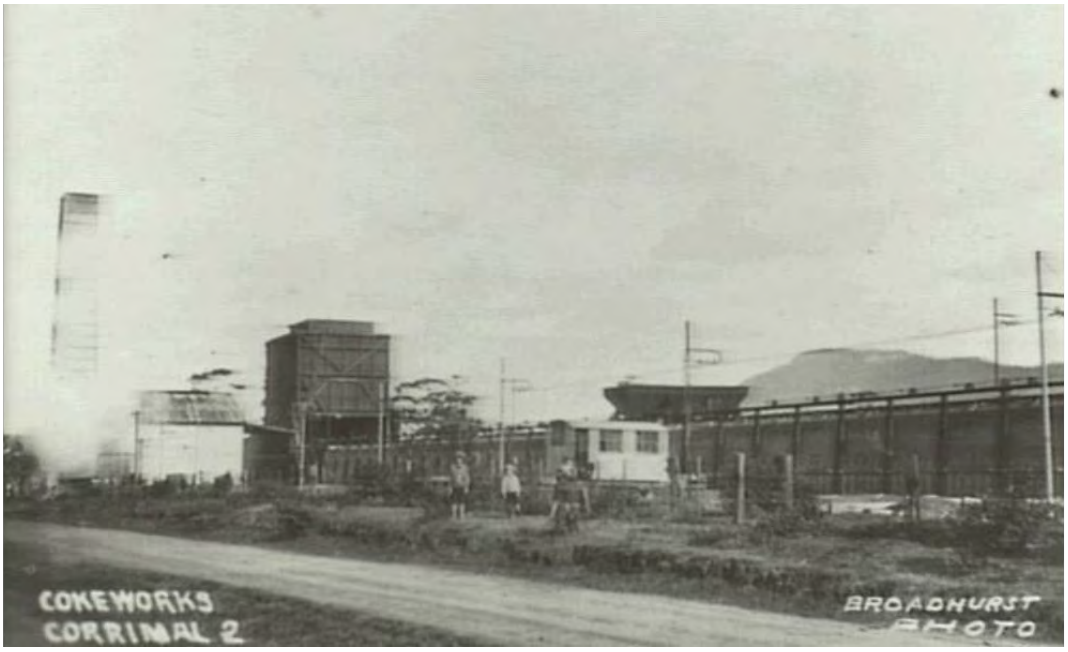


Photo 3. Corrimal Coke Works c1912 note the original brick chimney, Power House , C1 battery and 1888 vintage ram (pusher) car (relocated from Unanderra Coke Works in 1912) and original charge cars on top of the ovens Source: Illawarra Images Wollongong City Council

Photo 4. c 1961 C1 Battery Brick North Smoke Stack, and the 10-oven extension nearest the stack. Source: Illawarra Images Wollongong City Council.

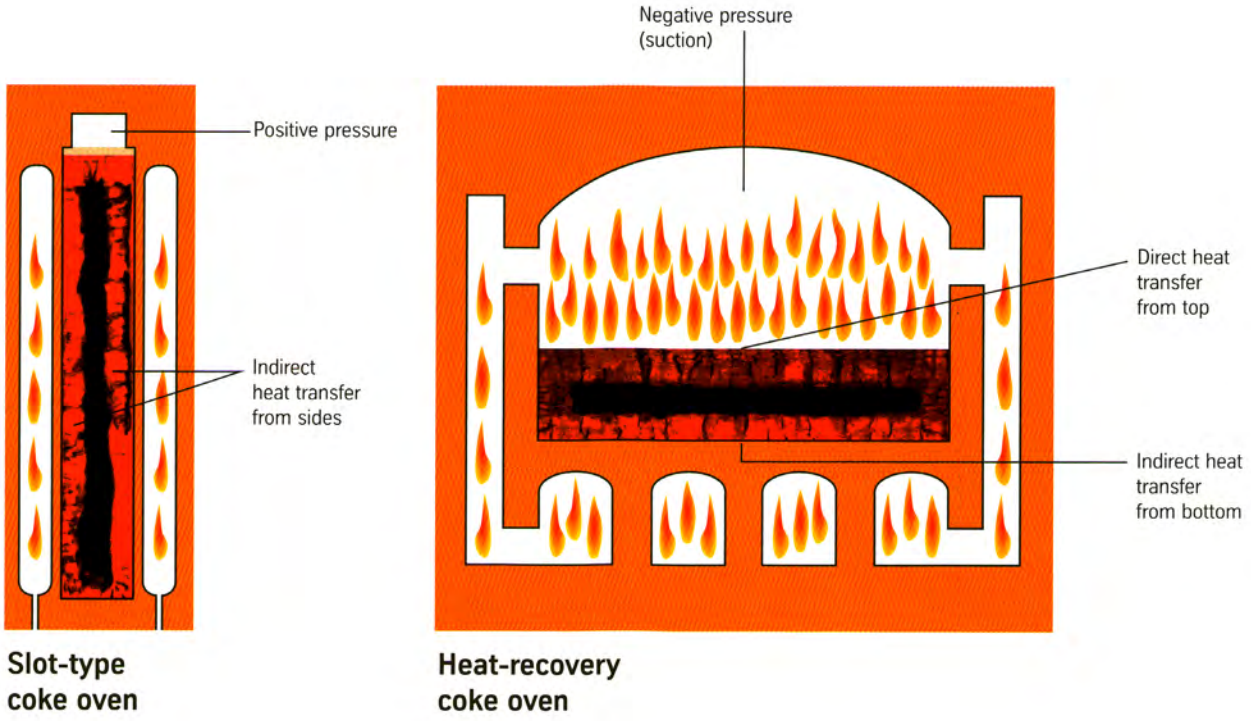


Fig 1. Diagrammatic representation of a Slot type Coke Oven and a Heat Recovery Coke Oven [as at Corrimal Coke Works]

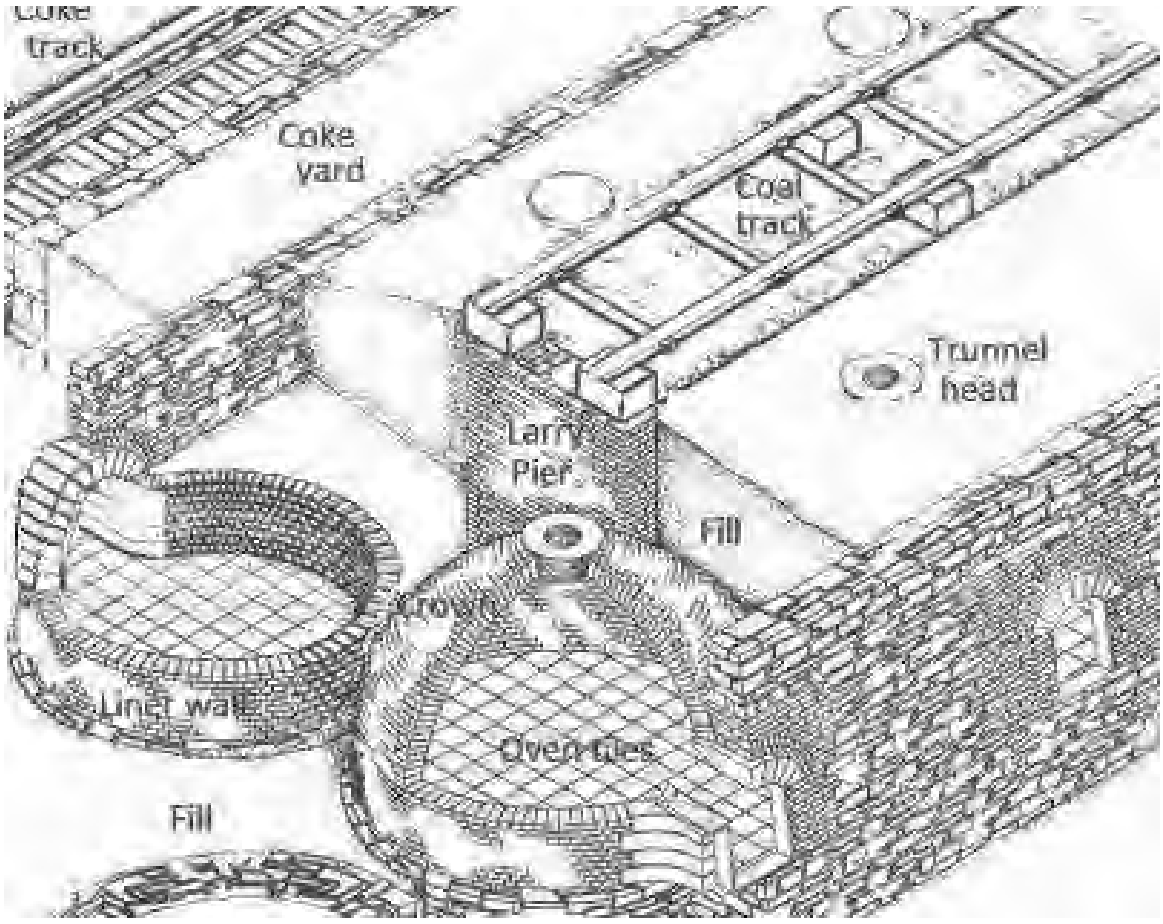
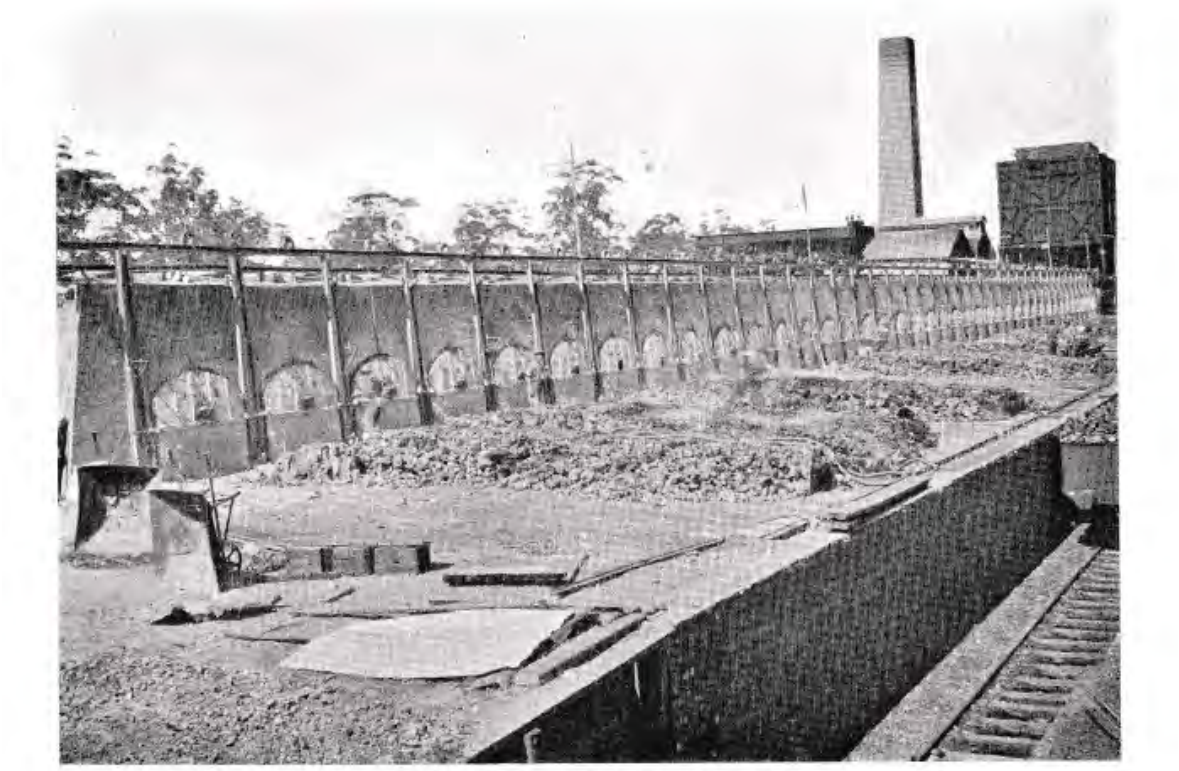


Fig 2 True Bee-Hive Ovens source Ref 1

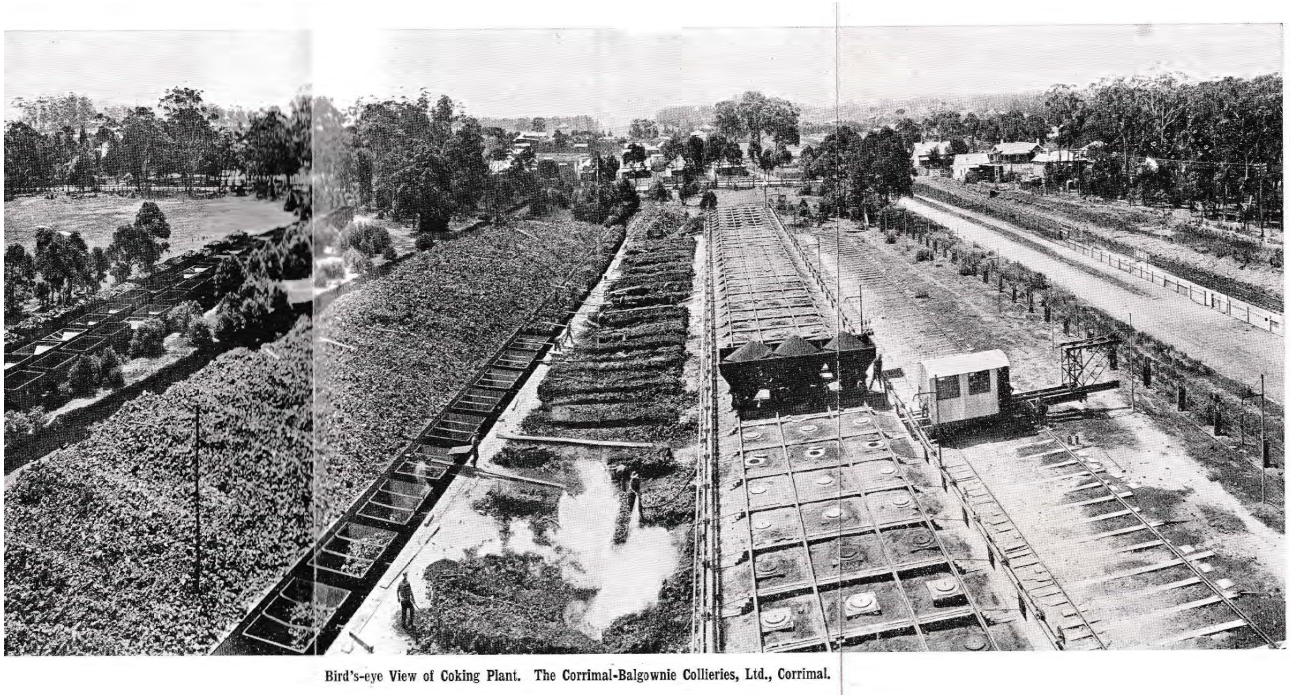


Corrimal-Balgownie Co.'s Ovens, Corrimal.

Photo 6 Corrimal Coke Works No1 Battery – Quenching Bench, 1500ton Fine Coal Hopper and Rail Siding 1916 Source NSW Department of Mines Ref 10

Photo 7. Corrimal Coke Works 2019 – showing C1 and C2 Batteries inc Fine Coal Bins and cross-over conveyor, Quenching towers and steam stacks and C2 South steel stack Source Daily Mail Australia

Photo 8 Corrimal Coke Works C2 Battery 2018 Source Daily Mail Australia



Bird's-eye View of Coking Plant. The Corrimal-Balgownie Collieries, Ltd., Corrimal.

Photo 9 Corrimal Coke Works C1 Battery – Quenching Bench, Rail Siding, Coke Stockpile, Oven tops, Charge Car and Ram 1916 Source NSW Department of Mines Ref 10

Corrimal-Balgownie Co.'s Ovens, Corrimal.

Photo 10 Corrimal Coke Works C1 Battery showing Ram, 1,500 ton Fine Coal Hopper , Cannister [Charge Car] 1916
Source NSW Department of Mines Ref 10

Photo 11 Corrimal Coke Works Source Illawarra Mercury

Photo 12 The photo shows the original timber gantry with hoppers discharging coal

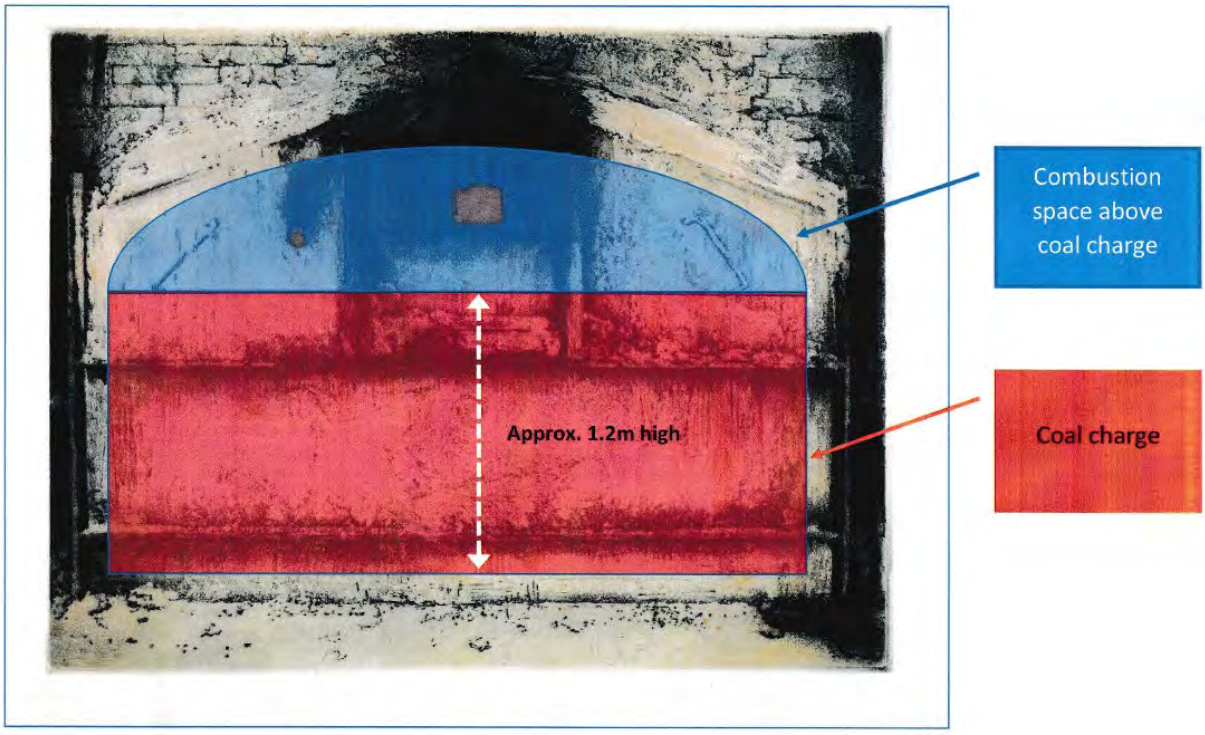


Fig 3 C1 Oven coal charge **Drawing by Ian Shepherd**

Appendix 5 Comparison of Corrimal Coke Works with former Coke Works

A comparative assessment has been undertaken with similar heritage sites that were in operation at the same time as Corrimal coke-works in order to establish and validate the engineering heritage significance of the Corrimal Coke Works

There are now no operational coke-works in Australia other than the recovery slot oven batteries at BlueScope Steel in Port Kembla NSW and Liberty Steel in Whyalla SA.

The remains of the once many Australian coke-works, situated mainly in New South Wales, represent the growth and decline of one of Australia's significant industries.

Following their abandonment, some industrial works have been demolished becoming archaeological sites, while others have re-developed for ~~othe~~r different purposes. As such, above-ground examples of decommissioned coke-works are comparatively rare.

G & C Hoskins & Co. Ltd, Iron Works Lithgow 1913 - 1928
This iron-works complex included a battery of 80 coke ovens of the Belgian design. The battery was developed over a similar time frame to the Corrimal Coke Works battery and initially used local coal. However, the coke produced by local coal was much inferior in quality to the Illawarra coke. This led Hoskins to purchase coke from the Illawarra coke-works for his needs and to later purchase the Wongawilli colliery in the Illawarra, and build a coke-works at the mine site to supply his work's needs. These coke-works closed down when the new Hoskins steelworks batteries were commissioned at Port Kembla in 1928.

Commonwealth Oil Corporation 1907 - 1912
The Commonwealth Oil Corporation established itself in the Wolgan Valley NSW to produce oil from shale; at the same time it established the town of Newnes. Its operation included a state-of-the-art complex of mines, retorts and a refinery. Although up to 120 coke ovens were planned, evidence suggests that only 90 were actually built.
The complex comprised the two original experimental ovens and 88 beehive ovens 12ft in diameter, laid out in an extended line of 45 ovens with duplicate ovens built back-to-back.

The quality of the coke was excellent for blast furnace needs – see Reference 3

The Osborne & Ahern Coke Works 1875 - 1890
To facilitate shipping of the end product, the four ovens were constructed adjacent to Wollongong harbour and an additional eight built at a later date. The harbour had been recently extended with the construction of Belmore Basin which included ship-loading staiths.

The beehive ovens first produced coke in 1876. Without operators of coke-making experience the venture failed, and what could be sold off was dismantled and sold in 1879.

Then, in 1885 two new ovens were constructed by William Ashley, who had coke-making experience. They produced saleable coke until 1890 when Ashley was employed as manager at Southern Coal Company's Unanderra coke-works.

The Bowen Coke Works 1933 - 2016
The Bowen Coke works at Bowen North Queensland was owned by Glencore.
In the 1930s the Queensland Government moved to establish the Bowen Coke works to use coal from the State Mine at nearby Collinsville to supply the smelters at Mount Isa with metallurgical quality coke. The design of the Bowen Coke works drew upon the successful coke ovens in the Illawarra and were of the longitudinal beehive pattern, using technology and expertise from Mount Pleasant coke-works that was closing at the time. The majority of these works production went to the smelters at Mount Isa, the balance being shipped to other smelting companies.

These works operated continuously on the site from 27 March 1933 until 2016.

Many other coke-works operated in Queensland, mainly on the Ipswich coal field. These were small operations and were located at the mine site where they obtained their coal

Bowen was one of only three examples of longitudinal beehive coke ovens in Australia. Given that there were probably were around 20 coke works operating in Queensland and probably around 50 in

Australia, the Bowen Coke Works, which faces cleared site demolition later this year, is comparatively rare.

The Coal Cliff Coke Works 1913 - 2013
The Coalcliff Coke Works is included in the NSW Environment, Energy and Science heritage listing for the Coalcliff Colliery Shaft Mine - Database Listing 2700808.

Owned by Illawarra Coke Company, the coke-works was constructed in 1913 consisting initially of 40 Thomas-type design oven batteries. Coke was first produced in December 1914.

The Coal Cliff works is significant from its association with Corrimal Coke Works. In 1984 the Illawarra Coke Company purchased Coal Cliff and combined with its now owned Kembla Coal and Coke Company, became the largest producer of non-ferrous metallurgical coke in Australia.

The 48 ovens were of the rectangular longitudinal bee-hive design.

The Coal Cliff coke-works is severely degraded in comparison with the Corrimal coke-works, due to its location in a high rainfall area, extreme vandalism due to its more remote location, and has a problem with access to it as the South Coast rail line cuts through the site.

Appendix 6 History Time Line of Coke Making in the Illawarra

Date	Occurrence	Comment
1848	First iron smelted in Ironworks established at Nattai [Mittagong] using charcoal as a fuel/ reducing agent?	Reported in SMH 7 June 1865 that coke was used in a new furnace [and charcoal in another furnace].
1849	Mt Keira mine established by Captain Schoobert	
1875	Osborne and Ahearn built two batteries of six beehive coke ovens at Wollongong Harbour	The coke works ceased operation 1879
25 05 1876	British & Tasmanian Charcoal Iron Company blast furnace first casting	The coke produced at Wollongong Harbour and Bulli proved too expensive so the company built 40 coke ovens at its site. Production began in September 1876 using Bulli coal as trials of Newcastle and Bulli coke showed the latter to produce a superior coke.
1879	William Ashley re-opened the Wollongong Harbour coke -works and later built two more ovens	The coke works ceased operations in 1890
1884	Thomas Bertram opened Brokers Nose Coal Company colliery1885 and built a set of 7 bee-hive ovens1886	The ovens operated sporadically and by 1890 were out of use Colliery closed 1887
1888	Southern Coal Company [SCC] formed in the UK to build a colliery at Mt Kembla, a railway from the mine to a new jetty at now Port Kembla	
1888	SCC Australian Coke Making Company constructed a battery of 92 beehive ovens at Unanderra	This was the first coke-works to produce coke on a viable commercial scale The weekly production was 400 tons
1888	SCC Mt Kembla mine ran into geological trouble and leased Thomas Bertram's Corrimal coal mining and railway facilities	SCC closed down Bertram's small coke works.
1888	Experimental blast furnace built in Wollongong	Patrick Lahiff used coke that had been produced by spontaneous combustion at the base of slack coal dumps
1889	Brokers Nose Coal Company was taken over by the Corrimal Coal Company	Southern Coal Company takes up a lease to operate Corrimal Colliery
1889	Bulli Coke Company built a set of 54 Welsh-type rectangular beehive ovens. Company subsequently acquired by The Bulli Colliery Coke Works Ltd	Colliery was connected by rail to their jetty at Sandon Point. In 1916 their main customer was BHP Associated Smelters at Port Pirie and overseas The coke works ceased operations in1930
1889	Mt Pleasant Coke Works Figtree and Sons built a battery of 40 McLanahan type longitudinal bee-hive pattern ovens	Situated alongside Illawarra railway 1 ¼ miles north of Wollongong Station Ceased operations in 1978.
1890	The Southern Coal Company purchased the Corrimal Colliery	
1899	My Lyell Coke Works built a battery of 36 rectangular beehive type ovens	Located at roadstead port of Five Islands [Port Kembla} near ERS.] for Queenstown [Tas] non-ferrous smelters Closed down 1925
1900	Federal Coke Works built a battery of 45 rectangular McLanahan type bee-hive ovens of modern design	Located Beaton Park. Ceased operations 1971
1900	South Clifton Coal and Coke Company built a set of 66 old fashioned bee-hive type ovens	Ceased operations in 1919
1901	Associated Smelters - Balgownie Coke Works built a set of 100 rectangular bee-hive ovens, Addition 15 constructed in 1916	Supplied various Broken Hill smelter operations that in 1915 were taken over by Broken Hill Associated Smelters who moved their operations to Port Pirie [SA] Ceased operations 1935
1902	Southern Coal Company reconstituted as Corrimal-Balgownie Colliery Limited.	
1906	North Bulli Coke Works re-erected at Coledale. Two sets of 52 rectangular beehive ovens	In 1912 a further 54 ovens were added Ceased operations 1926
1906	Quantity of coke manufactured in NSW 186,060 tons	NSW Dept of Mines annual report
1907	Quantity of coke manufacture in NSW 254,609 tons quantity manufactured in Illawarra 210,614 Number of coke ovens in Illawarra - over 500	NSW Dept of Mines annual report
1908	Quantity of coke manufactured in NSW 282,873 tons of which 228,778 tons came from the Illawarra Total output from the northern ovens 20,132 tons	NSW Dept of Mines annual report
1909	Reported that German coke could be landed more cheaply than NSW coke	Sydney Morning Herald 10 May 1909 page 5
1909	Reported there are 8 coke manufacturing works in the Illawarra with a total of over 500 ovens. Every coal mine on the South Coast feeds a coke works, and when in full operation the estimated output is around 5000 tons per week.	Daily Telegraph 20 September 1909 page 9
1909	Illawarra coke production 155,413 tons	NSW Dept of Mines annual report
1910	Figtree Bros built a large modern battery of 40 rectangular bee-hive [McLanahan}	Located North Wollongong Ceased operations in 1978

1910	Quantity of coke manufactured 282,337 tons	NSW Dept of Mines annual report
1911	Mt Pleasant coke-works added an additional 30 ovens	
1912	Bee-hive ovens at Wollongong Harbour demolished	
1910-12	Corrimal-Balgownie Collieries Ltd builds a very modern bench of 40 rectangular Thomas type beehive ovens	First set of coke ovens in NSW designed to recover waste heat to generate electricity
1913-4	The Illawarra Coke Company built 50 improved patent beehive ovens. First coke produced in 1914	Located at Coal Cliff. In1954 coke works were acquired by Kembla Coal and Coke Pty Limited 1960s another 8 ovens were added
1915	Over 500 operating coke ovens in the Illawarra G & C Hoskins Lithgow steelworks coke came from the Illawarra	
1915	BHP built a set of 66 Semet-Solvay recuperative ovens at Newcastle	BHP Newcastle Steelworks. The number of ovens was subsequently increased to 224 [1928]
1917	G & C Hoskins building a set of 40 Belgian type by-products ovens at Wongawilli	To supply coke to Lithgow. Coke also being purchased from other Illawarra coke-works
1918	Corrimal-Balgownie supplied excess electricity to North Illawarra Council for street lighting and domestic power	
1924	Additional 40 ovens added at Wongawilli. Now 80 ovens in service	Intention to supply all its needs from Wongawilli
1926	Mt Lyell coke-works closes down	
1927	Corrimal Coke Works first place in NSW to provide a bathhouse for workers	South Coast Times and Wollongong Argus 26 August 1927 page 21
1930	Corrimal- Balgownie Coke Company added an additional 8 ovens to its C1 battery	
1938	Wongawilli coke-works shut down	
1938	Australian Iron & Steel Port Kembla put into production 48 Otto Wilputte under-jet type by-product ovens	
1941	Wongawilli coke-works reopened	War time demand for steel
1948	Wongawilli coke-works closed	

Appendix 7 A Brief History of Coke Making & Coke Ovens Development

Coking

Coke is produced by the destructive distillation of selected bituminous coals at temperatures in the range from 900^0C to 1095^0C. The physical properties of metallurgical coke depend largely upon the coal used, the temperature at which it is carbonized and the uniformity of heating.

Not all coals will form coke, and not all coking coals will produce coke suitable for metallurgical and founding processes. Some coals will produce an acceptable coke without blending with other coals – as was the case in the Illawarra in producing coke from the Corrimal Coke Works and other beehive oven works.

During carbonization, which is carried out in a reduced oxygen atmosphere, up to 25-35% by weight, depending on the feed coal quality, is evolved as a mixture of volatile gases which burn to provide further heat to carbonise the coal.

As is the case today, in the second half of the 19th century, the technology of coking was continually being perfected by changing the geometry of the ovens – from round to rectangular hearths, and mechanization of oven operation.

Charcoal Making

Charcoal was the first known fuel used to reduce ores to melt and smelt metal so it could be cast into a desired shape. Charcoal burners fired cords of wood in sod-covered piles which admitted only sufficient air to burn the volatile materials in the fuel, and leave the charcoal; it was simple and cheap.

Coke Hearths

An increase in demand for charcoal and a reduction in the availability of a reliable wood supply led to the development of coke hearths or coke furnaces. In this process small coal was stacked around a central chimney and was reduced to coke i.e. carbonisation, by a process of controlled slow combustion in a reduced oxygen atmosphere.

Although it was a cheap method of producing coke, it was not of the quality desired by the smelters.

Beehive Ovens

From the mid-1600s, the next step in the technology of making coke was the use of a dome shaped structure with a hole at the top for charging the coal and a door at the bottom for drawing the coke. These partly enclosed ovens became known as beehive ovens because of the resemblance of their interior shape to traditional domed bee hives.

At the end of the 18th century coking was performed in partly closed chambers and, beginning in the early part of the 19th century, in closed chambers.

As with any other industry, the early days of beehive coking was characterised by simple structures and crude methods. Charging and levelling was carried out manually, as was raking out of the coke; air regulation was obtained by the rough-and ready method of inserting or removing bricks in the side door, as appropriate. No attempt was made to recover the sensible heat of the waste gases, or of combustion, or the unburnt gaseous or liquid decomposition products. And smoke and volatiles were discharged directly into the air through a vent at the top of the oven.

The strong growth in demand for iron and other metals meant coke with a specified performance was required to be supplied in greater quantities to iron makers and foundries.

Coke producers met this challenge by introducing improvements in the design and operation of the ovens. In 1861 the retort oven was invented by Evence Coppée; this new design excluded air from the coking chamber. The result was an oven that increased yield and offered further economic advantages.

This elongated style of oven was known colloquially as Belgian type ovens. While still called beehive ovens they had a rectangular hearth and an arched roof built with refractory brick.

The stage was set for ongoing improvements in the design of ovens. New ovens included hearths that were rectangular in shape, longer in length with the use of horizonal or vertical flues or a combination

of both, mechanical charging of coal and withdrawal of coke. Multiple ovens were now being built in batteries.

In 1869 a further improvement made by Simon Carves, enabled the by-products of combustion to be saved, and from these the modern of slot oven design has developed.

In the *Report on the Manufacture of Coke* produced for the US Department of the Interior in 1885, it was reported there were 86 different kinds of modified beehive ovens in use in the US.

These improved designs were based on suitability for the coal used, increased operational efficiency and operational volume. Further progressive improvements took place during the remainder of the 19th century.

Two types of ovens evolved; non-recovery and heat-recovery - the type built at Corrimal.
With non-recovery, the volatiles went to atmosphere. The heat-recovery type burnt the volatile gases and the hot waste gas, with the heat being directed to a boiler that raised steam, which drove a turbine[s] to produce electricity.

Later it became economically attractive to extract the by-products from the coking process and use them to make coal gas and industrial chemicals such as, tar, ammonia, ammonium sulphate, light oil [benzene, toluene and xylene] and naphthalene. For this purpose, a new type of oven developed – the slot oven, which was usually confined to a steelworks where heat was developed by the combustion of blast furnace gas [or coke ovens gas] in the ovens, while the more valuable coke oven gases were recovered, refined and stored for further use or sale.

Regardless of these improvements, a number of coke-works erected in New South Wales in the latter part of the 19th C used the earlier and less effective rectangular beehive shaped ovens.

Thomas Type Oven
The Thomas-type oven was designed by Samuel Thomas the son of a Welsh immigrant to the USA. The Thomas family owned a successful pig iron foundry, building a 75ft high blast furnace in 1888 and multiple beehive coke oven batteries to their own design – there were 910, on the site of their iron works.

The Thomas oven with an arched chamber was similar to the Welsh drag-oven but was considerably longer – 30ft as opposed to 12ft, and a little higher and slightly less wide. It had doors at both ends instead of only the one door of the Welsh oven

As with the Welsh oven the coke was dragged out to an apron where it was manually quenched with hoses to cool the coke.

Appendix 8 Known Coke Works that Produced Metallurgical and/or Foundry Coke in Australia 1853-1917

There were many attempts to produce coke in the then-known Australian coal fields. In the main part they were unsuccessful - few got beyond the planning stage and raising of finance. Of those that did, many did not get past the experimental ovens stage when they were built to test the suitability of the coke produced. Not surprisingly, even when a coke-works was built, many had short lives because the coke produced was either not fit for its intended purpose or the associated mine and smelters went out of business because of the distance to markets, lack of operating skills and financial constraints.

Commenced – Ceased Operations	Location of Works	Original Name	Pattern/ Type of Oven Total before closure
NEW SOUTH WALES			
1853-1861	Mereweather	Newcastle Coal & Copper Company	*7 likely old bee-hive* *First coke-works in Australia*
1861-1898	Minmi	Unknown	*32* old bee-hive
c1875	Plattsburgh Wallsend	Co-operative Coal and Coke Works	67 old bee-hive
1875-1878	Wollongong	Osborne & Ahern	12 old fashioned Bee hive
1879-	Wollongong	Ashley	2 old-fashioned Beehive
1877	Wallsend	Purified Coal and Coke Company	76 bee-hive
~1880	Lithgow	Eskbank Ironworks	Coke hearths
1885	Corrimal	Corrimal Coal Company	7 Harrison bee-hive
1888-1913	Unanderra	Australian Coke-making Co. Ltd	92 old fashioned bee-hive
1889	Bulli	The Bulli Coke Works	54 Welsh type bee-hive
1899	Port Kembla	Mt Lyall Coke Works	36 McLanahan bee-hive
1900	Wollongong	Federal Coke Works	45 McLanahan bee-hive
1900	South Clifton	South Clifton Coal and Coke Co Nth bench	66 old-fashioned beehive
	South Clifton	South Clifton Coal and Coke Co Sth bench	50 improved bee-hive
c1900	Rix's Creek Singleton	The Rix's Creek Coke Works	26 old-fashioned bee-hive
1898-1928	Lithgow	The Oakey Park Coal and Coke Company	Bee-hive
1889-1933?	Bellambi	The Assoc. Smelters [Bellambi Coke Works]	115 rectangular bee-hive
1903 - 1928	Lithgow	Oakey Park Coal and Coke	32 bee-hive 40 McLanahan
1906	Coaldale	North Bulli	106 Rectangular bee-hive
1908 - 1912	Newnes	Commonwealth Oil Corporation	Bee-hive
? – 1914?		Ashford Coal Company	6 bee-hive
1910-1978	Nth W'gong	Mt Pleasant Coke Works [Figtree Bros]	40 McLanahan type
1909 - 1923	Hexham	The Australian Coking and By Products Company Limited	48 Coppee
1912- 2014	Corrimal	Corrimal- Balgownie Collieries Ltd	40 Thomas type
1912	Lithgow	Lithgow Iron Works [G & C Hoskins}	93 rectangular Belgian
1913	Coalcliff	The Illawarra Coke Company	I40 improved patent beehive
1915 -1996	Newcastle	The Broken Hill Proprietary Newcastle Steelworks	66 Semet- Solvay Recuperative type ovens
1917-1948	Wongawilli	G & C Hoskins	120 Belgian type by-product
QUEENSLAND Note: *It was reported that at industries height there were over 300 ovens on the North Ipswich coal field All the coke-works were adjunct to mines and all ovens were beehive pattern. Brisbane Courier 18 11 1891 p6*			
?	Haigmoor		? bee-hive
?	Rothwell Haig		? bee-hive
1884	Mihi	John Wright and Brydon & Jones & Co	12 bee-hive
??	Old Tivoli		23 bee-hive
??	Wright's and Watertown/ Abermain		12 bee-hive
1942 – early 50s	Klondyke		? Bee-hive
1933 -2016	Bowen	Glencore	56 bee-hive
1890s - ?	Eclipse	John Wright	12 bee-hive

VICTORIA *none known*			
SOUTH AUSTRALIA			
1890s	Port Pirie	British & Westport Coke Coy.	30 Bee-hive
TASMANIA			
~1876-77	Zeehan	British & Tasmanian Charcoal Iron Co	40 bee-hive using coal from Bulli

Note: The information for the NSW coke-ovens was taken from Ref. 10

Coke Ovens Producing Metallurgical and Foundry Coke in NSW in 1916

(Department of Mineral Resources report).

Years of Operation	Location	Original Name	Type of Ovens
c1875	Plattsburgh	Wallsend Co-operative Coal and Coke Works	Bee-hive ovens
1877	Wallsend	Wallsend Purified Coal and Coke Company	Bee-hive ovens
1889	Sandon Point	The Bulli Coke Works	Welsh type ovens
1899	Port Kembla	Mt Lyall Coke Works	Improved bee-hive ovens
1900	Wollongong	Federal Coke Works	McLanahan type ovens
1900	South Clifton	South Clifton Coal and Coke Company	Bee-hive ovens
c1900	Singleton	The Rix's Creek Coke Works	Bee-hive ovens
c1900	Lithgow	The Oakey Park Coal and Coke Company	Bee-hive ovens
1901	Illawarra	The Associated Smelters [Balgownie Coke Works]	Rectangular bee-hive
1905	Lithgow	Oakey Park Coal and Coke	McLanahan type
1906	Coledale	North Bulli	Rectangular bee-hive ovens
1910-1978	Nth Wollongong	Mt Pleasant Coke Works	McLanahan type ovens
1909 - 1934	Islington	The Australian Coking and By Products Company Limited	48 By-products ovens
1912-2014	Corrimal	Corrimal- Balgownie Collieries Ltd	Thomas type ovens
1912	Lithgow	Lithgow Iron Works [G & C Hoskins}	Belgian type ovens
1913-2014	Coal Cliff	The Illawarra Coke Company	Improved patent bee-hive ovens
1915-1929	Newcastle	The Broken Hill Proprietary Newcastle Steelworks	Semet- Solvay Recuperative type ovens
1917	Wongawilli	G & C Hoskins	Belgian type by product ovens

Source Harper & Mingaye, 1916 NSW Department of Mines Report The Coke Industry of New South Wales p 67-71 Ref 10

Appendix 9 Author's Category of Award Assessment of Engineering Heritage Significance of the Former Corrimal Coke Works

Historical Significance	Indicate 'Agree' or leave blank	
	National or State heritage significant	**Other than National or State heritage significant**
Guidelines for inclusion		
Shows evidence of a significant human activity.		**Agree**
Is associated with a significant activity or historical phase.		**Agree**
Maintains or shows the continuity of a historical process or activity.	**Agree - National**	
Guidelines for exclusion		
Has incidental or unsubstantiated connections with historically important activities or processes.		
Provides evidence of activities or processes that are of dubious importance.		
Has been so altered that it can no longer provide evidence of a particular association		
Historic Individuals or Association		
Guidelines for inclusion		
Shows evidence of a significant human occupation.		**Agree**
Is associated with a significant event, person, or group of persons.		
Guidelines for exclusion		
Has incidental or unsubstantiated connections with historically important people or events.		
Provides evidence of people or events that are of dubious historical importance		
Has been so altered that it can no longer provide evidence of particular association.		
Creative or Technical Achievement		
Guidelines for inclusion		
Shows or is associated with, creative or technical innovation or achievement.	**Agree**	
Is aesthetically distinctive.		
Has landmark qualities.		
Exemplifies a particular taste, style, or technology.	**Agree**	
Guidelines for exclusion		
Is not a major work by an important designer or artist.		
Has lost its design or technical integrity.		
Its visual or sensory appeal or landmark qualities have been more than temporarily downgraded.		
Has only a loose association with a creative or technical achievement.		

Research Potential	Indicate 'Agree' or leave blank	
	International, National or State heritage significant	**Other than International, National or State heritage significant**
Guidelines for inclusion		
Has the potential to yield new or further substantial scientific and/or archaeological information.		**Agree**
Is an important benchmark or reference site or type.	**Agree**	
Provides evidence of past human cultures that is unavailable.		
Guidelines for exclusion		
Has little archaeological or research potential.		
Only contains information that is readily available from other resources or archaeological sites.		
The knowledge gained would be irrelevant to research, human history, or culture.		
Social		
Guidelines for inclusion		
Is important for its association with an identifiable group.		**Agree**
Is important to a community's sense of place.		**Agree**
Guidelines for exclusion		
Is only important to the community for amenity reasons.		
Rarity		
Guidelines for inclusion		
Provides evidence of a defunct custom, way of life or process.	**Agree**	**Agree**
Demonstrates a process, custom, or other human activity that is in danger of being lost.		**Agree**
Shows unusually accurate evidence of a significant human activity.	**Agree**	**Agree**
Is the only example of its type		
Demonstrates designs or techniques of exceptional interest.	**Agree**	
Shows rare evidence of a significant human activity important.		
Guidelines for exclusion		
Is not rare.		
Is numerous but under threat.		